Natural Resource Management for Recreation Development-
A Methodological Approach for Route and Viewpoint Planning in Taiwan

Yu-Lin Fan

Ph.D.
University of Edinburgh
1997

DECLARATION

I declare that this thesis has been composed by myself and the work is my own.

Yu-Lin Fan
Summer, 1997

ABSTRACT

The objective of this study is to improve the balance between the protection of a natural resource base and recreation provision within a national park area. This management objective was accomplished by the integration of data from questionnaire surveys with regression modelling and the use of a Geographic Information System (GIS). A case study on natural resource and recreation planning was carried out in the Chitou Forest Recreation Area (which has national park status) in Taiwan.

Data on the recreation preferences and demands of visitors were collected and investigated through questionnaires administered in the Park. Three areas were examined: the overall satisfaction with Park visits, the disincentives associated with crowd intensity and landscape component preferences. Visitor opinions were quantified and the relationship between variables and visitor preferences was investigated. The investigation involved the development of two regression based models, one dealing with overall satisfaction and the other with the impact of crowd intensity on visitor enjoyment. These models were combined with bio-physical and socioeconomic data from the Park including recreational resources, building costs, remoteness preferences and environmental sensitivity factors, and were utilised to plan a new path network system in the park. GIS was used to seek the best development solution which included maximising visitor satisfaction and minimising cost (both financial and ecological).

At the GIS analysis stage, IDRISI Multiple Criteria Evaluation (MCE), a decision support tool for multiple objective planning was adopted for three development scenarios designed to meet the different considerations of park management. Having identified the best potential additional viewpoints, a new pathway through these favoured areas was designed from a start point and end point which joined with the current path system. By this methodological approach, recreation preferences were quantified and integrated with GIS, and applied into recreation planning. The new pathway design met the Parks' recreation development objectives of low cost, abundant recreation resources, high satisfaction and ease of access.

ACKNOWLEDGEMENTS

The manuscript was carefully read by my supervisors, Professor John Barry Dent and Dr. Gareth Edwards-Jones. I would like to thank them, for their strong support in both academic and practical matters.

I would like also to thank the following people; Mr. Ji-Wei Huang who assisted in data collection and advice provision, and Mr. Jim Wright who kindly provided assistance and advice on the use of the GIS software. Mr. Wright also provided technique support and helped with the correction of related GIS Chapters. Mr. Tim Perkins gave the support of GIS techniques. Mrs. Kate Corcoran offered the related software and Mr. Bruce Currey helped with the transforming of digital data. Miss. Joanne Winston helped with the thesis correction while she was busy with her travel preparation. Mrs. Sandra Dent and Mr. Julian Smith kindly helped with part of thesis correction. I would like to thank them with all my heart.

The spiritual and financial support of my parents has been especially appreciated. The support made it possible to study a PhD. abroad and concentrate on learning without worry.

Finally, I wish to acknowledge the Park manager and staffs of Chitou Forest Recreation Area for providing me with the access to the data and essential support during the field survey. I would especially like to thank the former Park managers, Professor Yung-Nai Yao and Hung-Tao Hu, and staffs including Mr. Chi-Wen Leong, Mr. I-Kai Hung, Dr. Ju-Yuan Liu, Dr. Nien-June Chung and Miss. Chen-Ni Tseng for their data provision and assistence. Professor Hu's strong support helped with the success of field survey. In addition, I would like to send my thanks to Professor Jih-Ching Liao at the Department of Forestry, National Taiwan University for his provision of information.

I extend my sincere thanks to all concerned.

LIST OF ACRONYMS

DTM:	Digital Terrain Model (Topography)
FA:	Factor Analysis
F.I. (F.):	Fragmentation Index
GIS:	Geographic Information System
LR:	Linear Regression Analysis
LRA:	Logistic Regression Analysis
MCE:	Multiple Criteria Evaluation
N.T.U.:	National Taiwan University
RPM:	Recreation Preference Model
SBE:	Scenic Beauty Estimates
YHC:	Youth Hostel Centre

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1. INTRODUCTION

1.1 Introduction and Location of Study Area- Chitou Forest Recreation Area

A. History, Location and Area

The Chitou Forest Recreation Area (abbreviated as Chitou) is part of the Chitou Tract of Experimental Forest. The area was entrusted to the College of Agriculture, the National Taiwan University (N.T.U.), in 1949 for conservation, academic research and education. In addition, in 1970, the area became established for recreation.

Chitou administratively belongs to the Nantou Hsien region in central Taiwan, an island in the West Pacific Ocean near the south-east end of China. The Tropic of Cancer lies across the south of the country (Figure 1.1).

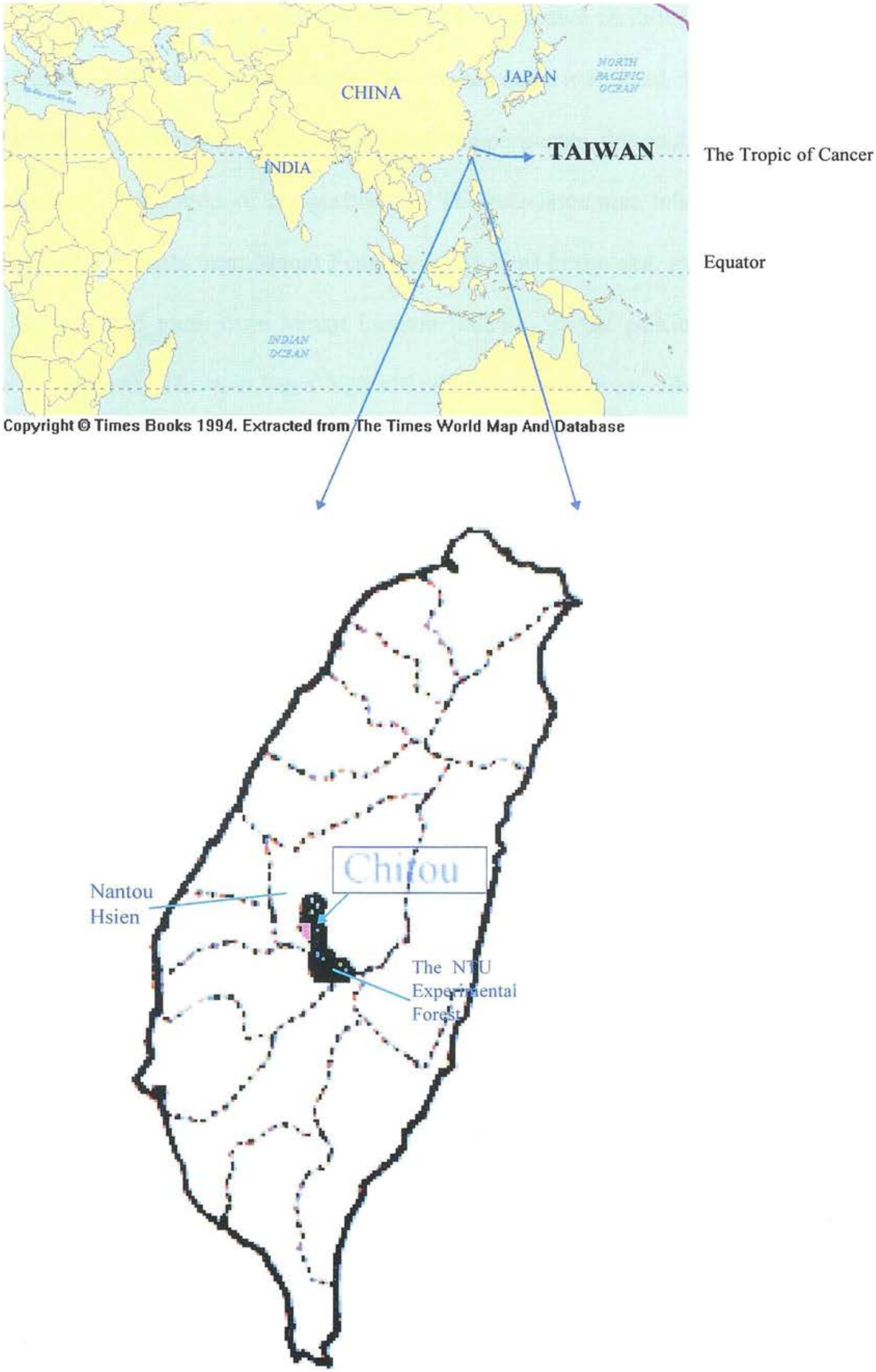


Figure 1.1 The location of Taiwan and the study area (Chitou)

The Park's high popularity has lead to pressure on its recreation facilities, this factor, and the availability of data information on the area has made it an ideal study site for this project. The Chitou Tract is designated into 6 compartments, this study will cover compartments 3, 6 and most of compartment 2. The recreation area falls within the study area which extends from Mount Fenghuang (1653m) in the east, to the Yenchi road in the west and south from Mount Lingtou (2025m), to the parking lot at the entrance in the north. The area has a high altitude to the Southwest side and slopes away to the north. For the purpose of this research, the study site will be referred to as Chitou. This area of Chitou is about 400 hectares and is divided into the Ecology Protection Area (natural forest area in Mount Fenghuang), the Farm Area, the Forest Area, the Recreation Area and the Public Facility Area.

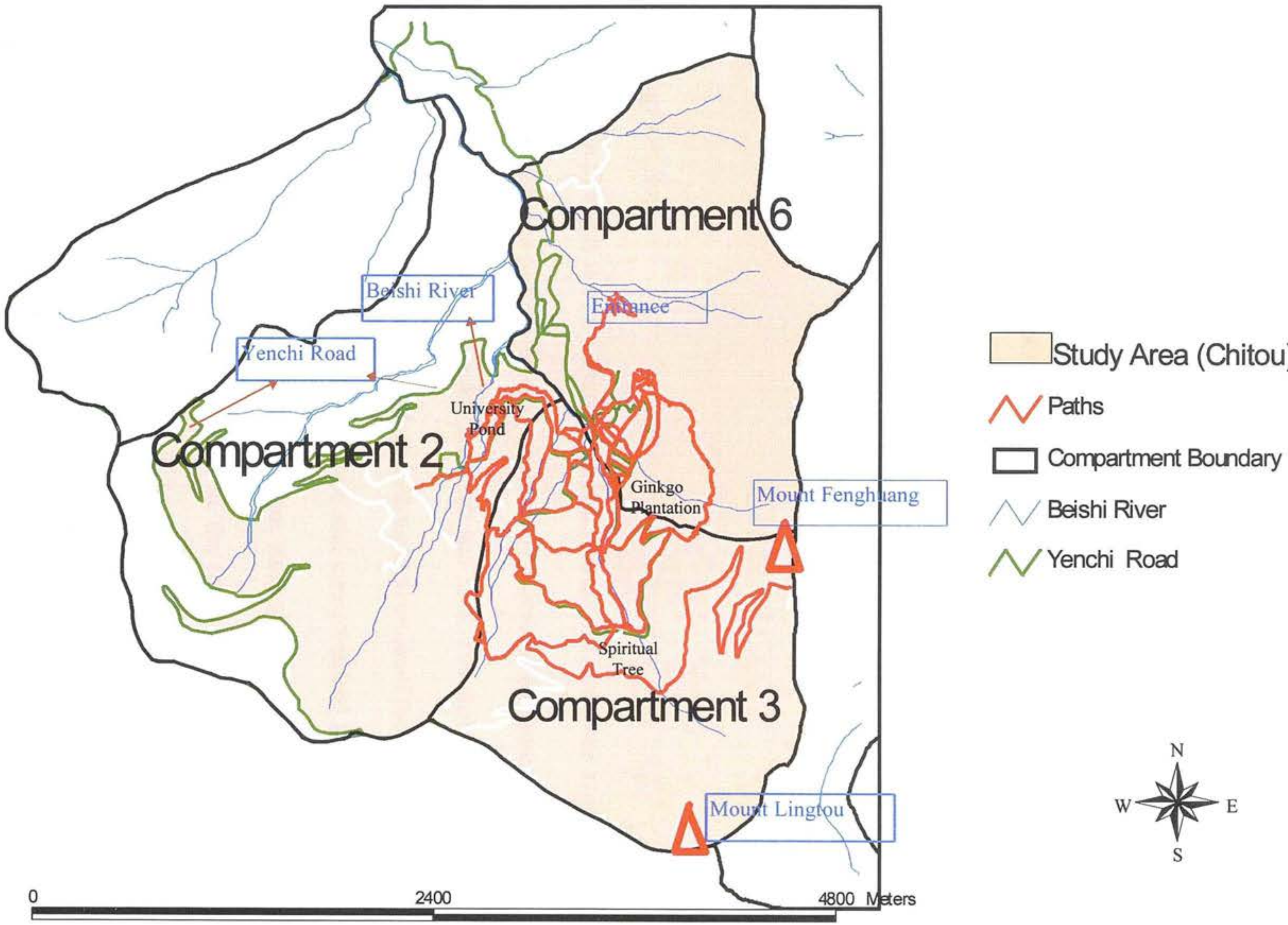


Figure 1.2 The map of study area in Chitou Tract.

B. Topography

The altitudinal range of the Chitou is between 600 metres and 2000 metres above sea level. The main topography of the zone, which is effectively the western slope of Mount Fenghuang, is full of barren mountain ridges and unfavourable terrain. Relatively gentle slopes are found only in small areas at the foot of the mountains.

The river Beishi and its tributaries extend throughout the Park meeting in the northern part of Chitou. The name 'Chitou' (meaning the origin of rivers), comes from this physical characteristic.

C. Geology and Soil

The geology in this area is of the Tertiary period. Arenaceous shale was accumulated together with sandstone to form layered contours. The developing sandstone is more noticeable than the shale and the layers are thick and hard. The shale layers are thin and brittle and contain fossil sea life, which is thought to be proof that this island was once under water and, therefore, has academic and conservational value. There are often 90 degree collapses in Chitou because of the steep and treacherous slopes (The Experimental Forest, N.T.U., 1993). In addition, the continued flushing action of the monsoon rains have caused the collapses to worsen and become more widespread over time.

Soil types in this area are mostly sandy. Generally, in the treacherous, steep areas, the soil is shallow in depth, whereas the soil in the more gently sloping areas is deep and rich in humus. The combination of steep terrain and monsoon rains makes soil leaching a problem in the area.

D. Climate

The annual average temperature in the region is 16.8 °C. January and February are the coldest months (average 11.7 °C) and July and August are the warmest (average 20.7 °C). The average annual rainfall is approximately 2700 mm. The dry season lasts from October through to April. Based on publications from the Chitou authorities (The Experimental Forest, N.T.U., 1993), 81 percent of the average annual rainfall occurs during the rainy season with around 67 percent of the rainy days occurring during this period. The average relative humidity for the Park exceeds 89 percent.

E. Transportation

The main link to Chitou from the outside world is the Yenchi road, which connects to cities in the north and south (2 hours and 1 hour, respectively). The cost of transportation from the nearby cities in the usual mode of transport (buses/cars) is approximately £3.60 per person or less.

F. Economic Activities and Land Utilisation

Economic activities for local residents are primarily agricultural (i.e. farming, but also including forestry, fisheries and ranching). Employment in such activities in the surrounding townships in 1987 ranged from 33 to 82 percent (The Experimental Forest, N.T.U., 1993). The Chitou area contains a large amount of land which has been contracted out to local tree farmers who cultivate the land mainly with bamboo (The Experimental Forest, N.T.U., 1993).

G. Plant Resources

Man-made forests are the main elements of management in Chitou. *Cryptomeria japonica* (Taxodiaceae) and *Cunninghamia lanceolata* (Taxodiaceae) plantations account for over 70 percent of the area. *Taiwania cryptomerioides* (Taxodiaceae) and *Chamaecyparis formosensis* (Cupressaceae) plantations cover about 10 percent of the area. Bamboo plantations are predominately *Phyllostachys pubescens* followed by *Phyllostachys makinoi*. Cultivated broad-leaved forests of *Pulownia taiwaniana* (Scrophulariaceae) and *Alnus formosana* (Betulaceae) only occur in small areas.

Current management objectives are to increase the areas of mixed plantations, to decrease squirrel damage, and to increase the conservation value of the area. Broad-leaved species adopted for establishing mixed forest include *Liquidamber formosana* (Hamamelidaceae) and *Prunus companulata* (Rosaceae). Amenity considerations are of growing importance to the Park.

Along with amenity, conservation has always been, and continues to be vital to the Park. A large area of natural broad-leaved forest, abundant in wildlife, to the west of Mount Fenghuang has been designated as a protected area. The pathway to the top of the Mountain is famous for bird watching (top 100 in the World (Yao, *et al.*, 1995)).

The small areas of natural forest remaining are interspersed through the rest of the Park area - many of those areas contain bamboo.

The major natural forest types present in Chitou are divided into four broad types as follows:

(1) *Beilschmiedia erythrophloia- Machilus japonica- Pasania kawakamii- Turpinia formosana* type: Between 1,200- 1,500 metres above sea level in the Mount Fenghuang area.

(2) *Castanopsis carlesii- Cyclobalanopsis longinux- Litsea nantoensis* type: Between 1,500- 1,700 metres above sea level in the Mount Fenghuang area.

(3) *Castanopsis carlesii- Trochodendron aralioidies- Rhododendron ellipticum- Yushania niitakayamensis* type: Between 1,600- 2,000 metres above sea level along the edge of Mount Fenghuang and Mount Lingtou.

(4) *Rhododendron formosanum- Yushania niitakayamensis* type: separately distributed between 1,600- 1,700 metres above sea level along the edge of Mount Fenghuang.

There are more than 30 species of rare plants in the Park such as *Dysoma Pleiantha* (Berberidaceae), *Rhododendron kawakamii* (Ericaceae) *and Taxus mairei* (Taxaceae) and more than 20 species of 'special crops' with specific use (i.e. for food production) such *as Cryptotaenia canadesis* (Umbelliferae) and *Bauhinia champioii* (Leguminosae). Chitou also contains more than 50 species of medical plants including *Dysoma pleiantha* (Berberidaceae) and *Selaginella doederleinii* (Selaginellaceae). All these species contain a high attraction and educational value. In addition, the 'spiritual tree' (*Chamaecyparis formosensis*) (Taxodiaceae) which is 2,800 years old; the splendid bamboo plantations and the only *Ginkgo biloba* (Ginkgoaceae) plantations (living fossil trees) in Taiwan are all famous and important from both conservation and recreation points of view. There are many experimental research and educational facilities with recreation functions within the area, including a conifer arboretum with over 70 species of domestic and foreign conifers.

H. Animal Resources

Within the area, there are 9 mammal species, 7 of which are endemic. Birds, reptiles, amphibians, butterflies and fish are also found. All taxonomic groups have a high percentage of endemic species or subspecies (Table 1.1).

Table 1.1 The number of species of each animal and endemic proportions recorded at Chitou between October 1989 to September 1990

Animals	No. of Species	No. of Endemic Species or Subspecies	Endemic Percentage(%)
Mammals	9	7	78
Birds	85	43	51
Reptiles	20	4	20
Amphibians	7	2	29
Fish	6	1	17
Butterflies	73	7	10

(Data from Lin and Chou, 1992)

Formosan rock-monkeys (*Macaca cyclopis*) and the Formosan-ferret badgers (*Melogale moschata subaurantiaca*) are largest mammals in Chitou, but are seldom seen. Small mammals are mainly squirrels such as the Formosan red-bellied (*Callosciurus erythraeus roberti*) and the Large red flying squirrels (*Petaurista

petaurista grandis). There is an abundance of bird species found within the natural forest areas together with a great number of butterfly species (there are 73 species of butterfly in Chitou). Frogs are the most important amphibians and *Rana sauteri* is one of the most remarkable frog species among them. Chitou's summer and autumn are the seasons when snakes and lizards are observed which are the main reptiles in the area (Lin and Chou, 1992).

1.2 Background and Problems Encountered in Chitou

One of the Park's main management aims is to ensure the forest provides adequate recreational facilities, education opportunities and plenty of areas for rest and relaxation. The last objective is especially important considering that Taiwan is a small island with the second highest population density in the world (572/sq. km[*]). As a result, there is a great requirement for outdoor recreation areas and for opportunities to be close to the natural environment.

Approximately one million people have visited the Park every year since 1977, making Chitou one of the most popular recreation areas in Taiwan. Crowds are obvious at key locations (in bus stations, parking lots, the entrances, restaurants and some popular viewpoints) during peak times in the summer vacation.

[*] Data based on 1993 Times World Map And Database.

At one of the most popular viewpoints, University Pond, serious soil erosion and soil hardening due to trampling, has previously been a problem. Some attempts to improve the area (fencing along the Pond and planting) have been carried out, however, the soil is still not fully recovered and the average number of summer and weekend visitors still continue in excess of the area capacity. Pressure on recreational facilities causes other impacts such as noise, and wildlife habitat interference. Solutions to such pressures would involve the provision of more recreation viewpoints and the redistribution of visitors by route arrangement. To achieve this redistribution, careful planning to lead people to the honeypot areas (attractions where managers would like to attract visitors) through the more robust areas in the Park avoiding those fragile sites is essential. Low cost and low environmental impact should be considered also.

The mountains in Taiwan are steep and the rivers are short, consequently, well managed forests are of great importance to the national soil and water resources. The high ecological value of the Park makes environmental conservation more important here than in any other areas of the country. Habitat changing activities such as logging may cause impact to wildlife. For this reason, development in areas with unrecoverable resources or endemic species should be avoided to prevent irreplaceable change.

The problems and pressures encountered here can be summarised as the need to provide greater enjoyment of recreation (landscape, recreation facilities and spaces, etc.), improvement of wildlife and ecological conservation, reduction of competition from other land uses and enhancement of landscape amenity (Figure 1.3).

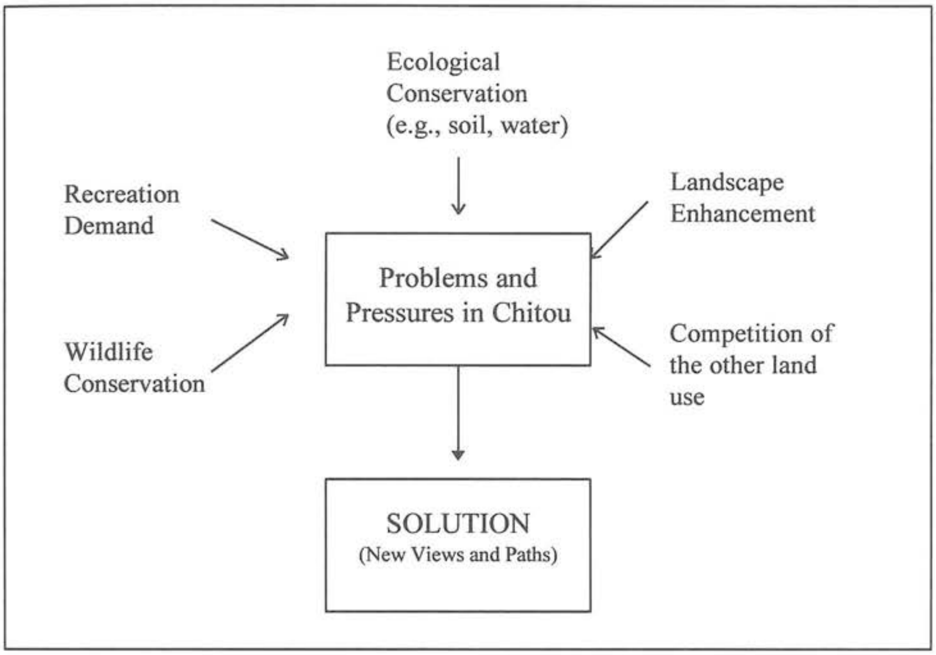


Figure 1.3 Current problems and pressures encountered in Chitou.

1.3 Objectives and Hypotheses

The aim of this study is to examine the above problems and to determine whether they may be resolved by creating new viewpoints and connected pathways. A research method for planning recreation in parks, especially the location of viewpoints and route alternatives, will be explored considering ecological, economic and recreational demands. This methodological approach involves interdisciplinary studies, by integrating social science into modelling and GIS-based environment.

Through these objective approaches, this study will examine the hypotheses that GIS can be used to analyse recreation preferences of visitors to a Park in Taiwan which contains National Park status and can be used as a natural resource and recreational management tool.

CHAPTER 2. PREVIOUS RESEARCH

2.1 Outdoor Recreation and Natural Resource Studies

2.1.1 Outdoor recreation, environment planning and management studies

Recreation has previously been defined as "refreshment of body or mind by activities, or a planned inactivity, undertaken because one wants to do it, without any moral, economical, social or other pressure" (Pearson, 1961; Clawson and Knetsch, 1966; Zee, 1986 and 1987). Torkildsen (1992) concluded the recreation theories and defined recreation as "needs-serving, leisure-time activity, value to individual and society, a re-creation and a kind of satisfying experience."

A current problem for management aiming to protect natural resources is contending with increasing wilderness interest groups. There are also increased demands for wilderness experiences such as outdoor recreation. Such demands have created an ever greater need for prudent management of natural areas (Kliskey, 1994a, 1994b). Pigram (1985) cited that "the primary aim of outdoor recreation management is to bring together supply and demand- to attempt to equate resource adequacy and human recreational needs and desires with minimised environmental degradation". If this is to be achieved, well designed and managed recreation sites are required. Brown (1977) proposed a 'recreation management process' (Figure 2.1) which covered the setting of management objectives, the estimation of carrying capacity and the selection of well planned management procedures.

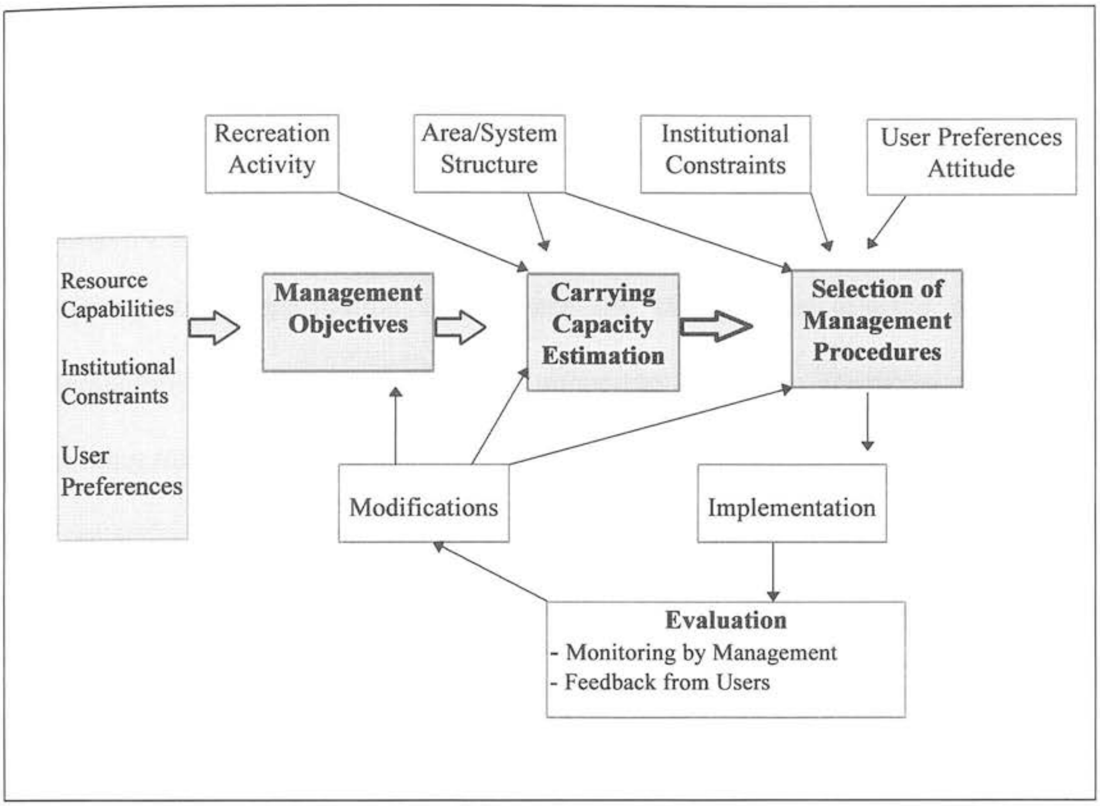


Figure 2.1 The recreation management process (including the setting of management objectives, the estimation of carrying capacity and the selection of well planned management procedures) (Brown, 1977)

Selman (1992) highlighted the importance of minimising recreation impacts for park management. Methods such as fencing, the betterment of footpath surfaces, re-routing of the path systems and site treatment with topsoil, fertilisers, turves, etc. were recommended.

The estimation of carrying capacity is important when planning and developing recreation areas. Methods for the estimation including observation, site surveys, questionnaire surveys, interviews, census, published information, aerial photographs and site development plans have been attempted (Selman, 1992; Sowman, 1987).

The management of visitors is also another part of essential recreation management, and has been classified into direct and indirect methods (Selman, 1992). Direct management methods limited the access of visitors. Indirect methods were to encourage the redistribution of resource use through the selected provision of information (including interpretation) about the recreation resources in that area including route arrangement (guided walk, pathways, path surfaces, entrance, location of car parks, etc.) (Countryside Commission, 1985; Lucas, 1985; Selman, 1992). As Selman (1992) stated, the direct management method may intrude into the recreational experience and, therefore, may not always be appropriate. The creation of 'honeypot routes' through attractive but robust areas is an alternative method, and the most effective measure for the decreasing impact from visitor pressure in popular viewpoints (Selman, 1992: 88, 95).

On the aspect of recreation planning, Ruemler (1988) submitted four stages of the 'Landscape Management Contributions (Process)' for road planning. These stages are; environmental impact study, accompanying landscape management plan to the preliminary design plan, accompanying landscape management plan to the final design plan and final landscape management execution plan. This structure of planning can be considered in project construction. The traditional 'overlay mapping techniques' are used in Ruemler's project to combine an individual map of the landscape types into road planning.

Physical features of the trail settings are essential when considering visitor enjoyment. The results can be used as a guide for path planning, design and maintenance (Wiberg-Carlson and Schroeder, 1992).

It has been indicated by Clawson and Knetsch (1986) that within a single recreation area, as much as 95 percent of the total use may occur in as little as 5 percent of the area. Therefore, redistribution of the pathway network to avoid the overcrowding in some popular viewpoints is often necessary. Even though there may be some disturbance to the most isolated areas, the largest part of the area can be managed with minor impact only (Zee, 1990). In addition, previous visitor studies (Zee, 1988a, 1988b and 1990) found a positive association between high (widely) use park area with visitor accessibility and recreation quality, except when the site scenic quality was too low.

Landscape management is vital in today's recreation issues. As Zee (1990) indicated "Landscape features are resources only when man identifies them and uses them as such. They may have no original relation to recreation". The relation between landscape and recreation could be approached by a number of ways (Zee, 1990). Such methods include land evaluation, recreation impact analysis, visitor pattern spatial analysis and landscape amenity evaluation. Zee (1990) adopted interview skills for land evaluation and aerial photos in the inventory of spatial visitor pattern analysis.

2.1.2 Visitor recreation perception

Based on the definition given to perception in the 1993 Collins COBUILD English Language Dictionary 'a perception is a belief or opinion that you have as a result of realising or noticing something, especially something which is perhaps not obvious to other people; perception is the awareness of things that you have by means of your senses, especially the sense of sight such as visual perception'. In this study, visitor recreation perception is estimated in terms of recreation satisfaction preference, recreation crowd density preference (the extent of tolerance) and landscape component preferences. Previous research carried out on recreation preferences excluding landscape component preferences, which is detailed in Section 2.1.3, will be described in this section.

Conflicts in outdoor recreation occur as visitors compete for the same physical, social and psychological space during the same time period (Lindsay, 1980). Roggenbuck *et al.* (1993) and Kliskey (1994) highlighted the variation of visitor perception to wilderness experiences and emphasised the need to manage different zones for different user groups. This theory of user opinions and perceptions could be evolved into the management process (Roggenbuck *et al.*, 1993 and Kliskey, 1994). The evaluation of perception response has been studied by many behavioural geographers and environmental psychologists (Wolhwill, 1973; Ittleson *et al.* 1974; Brush, 1976; Craik and Zube, 1976; Duncan, 1978; Desbarats, 1983). Previous study has also included the methods of management objectives, behaviour and socioeconomic profiles applied on decision making with the use of questionnaires (Dent and McGregor, 1994; Morgan, etc., 1996). In McGregor, etc. (1996) a pilot study attempted to include a variety of psychological, environmental and related variables into the decision making process.

2.1.3 Amenity and landscape preferences

Amenity and landscape are parts of the recreation resources. Considering their visual features, they will be taken account of separately while exploring visitors' perceptions and recreation resource management.

Landscape is synonymous with land and environment and includes the meaning of scenic beauty (Zonneveld, 1979; Vink, 1982; Bartkowski, 1985; Zee, 1990). Previous to 1970, human perception of landscape was seldom analysed (Daniel and Boster, 1976; Arthur, 1977; Hull and Buhyoff, 1986; Brown, 1987). Today, there is more emphasis on the quantification of landscape preference and amenity experience. Scenic beauty estimates (SBEs) are the main method of quantifying landscape preferences (Shafer, *et al.*, 1969; Daniel and Boster, 1976; Arthur, 1977; Daniel and Schroeder, 1979; Daniel and Hull *et al.*, 1984; Vodak *et al.*, 1985; Brown and Daniel, 1986; Hull and Buhyoff, 1986). Other quantification methods such as: assigning sums of ranks or averaging of ratings to landscape preferences (Shafer *et al.*, 1969; Brush, 1979), transformation of ratings to obtain scenic beauty estimates (Daniel and Boster, 1976) and scaled paired judgements (Buhyoff and Leuschner, 1978; Tips and Savasdisara, 1986) have also been used. Results show that there is no significant difference in the results obtained between the SBEs ranking and scaled paired judgements (Buhyoff *et al.*, 1980, 1981; Hull *et al.*, 1984).

Rasmussen (1991) used a quantification method which sought to quantify the visibility of a view within a forest environment. The forest manager was then able to perform a comprehensive analysis of the potential impacts and effects of various management practices. His study also sought to quantify the visibility of a view by simulating various positions of observers within forest.

A study to quantify land types and rank priority was carried out by Christodoulou and Nakos (1990). Methods used to rank the land types included surveying, mapping and other evaluation procedures. Each unit of land (map unit) was assigned 'relative importance values' according to its land capability class for alternative land use. The land was ranked by interest groups and decision makers depending on the type of development desired.

A quantitative study to examine scenic beauty preference of a coastal pine forest was carried out by Eleftheriadis and Tsalikidis in 1990. These preferences were related to quantitative measures of land use designations, and to forest stands. Predictive models were created and landscape information was incorporated into the planning process.

Brush (1979) asked interviewees to view various scenes in photographs. Preference scores for each physical feature were assigned. The feature was scored, based on its prominence in the scene. Quantification of visitor preference was then examined. In addition, Tips and Savasdisara (1986) used a landscape preference matrix to conduct a sociocultural comparison of landscape features. The use of photographs and questionnaires for landscape evaluation was also adopted by Wiberg-Carlson and Schroeder (1992) in a trail preference study.

Some researchers argue about the methodology of landscape preferences, especially the quantitative aspect. Nelson (1984) and Pearce and Waters (1984) have both pointed out that the analyses of the data had to take account of the effect of environmental, social, psychological, economic and cultural factors upon human behaviour. Criticism has also arisen over the use of the photographs to estimate preferences. Wiberg-Carlson and Schroeder (1992) pointed out the weakness of this method is that some photographs didn't represent the themes or the attractiveness of the scene well.

In this study, quantification methods including scenic beauty estimates and ranking are the main visitor preference estimates used, especially in landscape related investigation.

2.1.4 Statistical analysis in recreation studies

To compare landscape preferences of the various groups on abstract pictures, the Spearman rank correlation coefficient (Tips and Savasdisara, 1986), the Kendall coefficients of concordance (Tips and Savasdisara, 1986) and the Pearson linear correlation coefficient (Tips and Savasdisara, 1986) have been used.

Regression models have been used to predict landscape preferences, aiding forest or wilderness management and planning (Hyberg, 1987; Pukkala *et al*., 1988; Eleftheriadis and Tsalikidis, 1990; Kangas, 1992; Kangas, *et al*., 1993). In addition, Wood (1987) designed a model to predict recreation impact. In the method of Pukkala *et al*. (1988), the variables in the model were chosen manually. Besides multicriteria weighting methods (Howard, 1991), and ratio scales, comparison scales have all been applied (Hull, 1989; Kangas, *et al*., 1993) to estimate the scenic beauty index of a landscape.

2.1.5 Natural Resource and Recreation Studies in Chitou- *(wildlife, soil, geology, climate, visitor survey, recreation planning/ management)*

There are not many publications on Chitou forestry. Studies have previously focused on classification of plant species (Liu, 1970; Liu, *et al*., 1972; Liu, 1973; The Experimental Forest, 1979a). Kuo (1958) was the first to publish a formal paper about plant ecology in the area. He examined three dominant cover plants in a Cryptomeria stand.

Lin and Chou (1992) indicated that Chitou is abundant in animal resources. The mammals, birds, reptiles, amphibians and fish have all been previously studied (see Table 1.1). The animal ecology and behaviour of the areas including squirrels, mice, birds and frogs is well documented also with over 10 Ph.D. and other studies previously carried out in the region. The butterfly classification in Chitou has also been examined (Yang and Liu, 1988; Lin, etc., 1992). The area's geological, geomorphologic and forest soil characteristics have also been studied (Chen and Chang, 1987; Ho, 1977).

Since recreation has been defined as one of the multiple management objectives of Chitou, related researches are increasing. Chitou is one of the most popular Recreation Areas in Taiwan (Huang and Liu, 1987; Huang, 1989), and between 1977 to 1993, a 20th of the Taiwan population has visited Chitou annually (Figure 2.1).

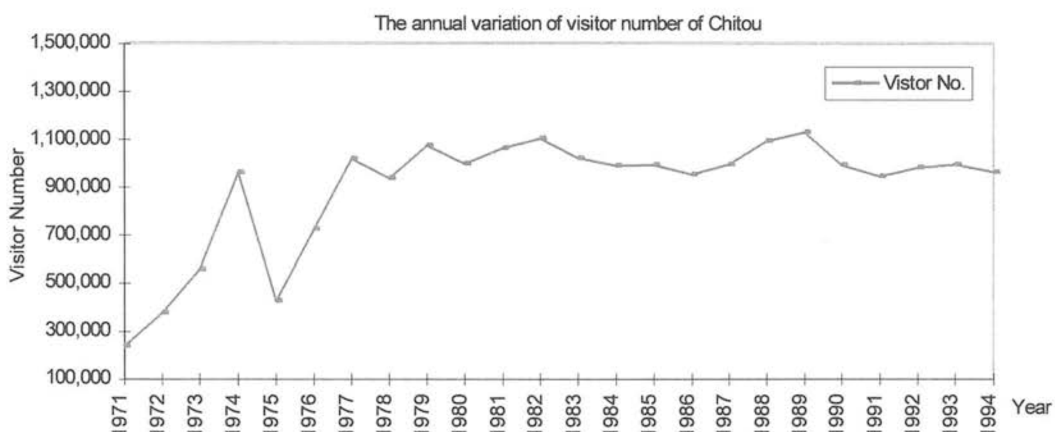


Figure 2.1 The annual variation of visitors to the Park (Information from Huang and Liu, 1987)

Research (Liu *et al.*, 1984) has shown that the main reason for people visiting the area is for sight seeing, walking and relaxing. 44.2 percent of visitors are students and 49.6 percent of visitors come from a university background. It is important that the Chitou management considers this when planning education and recreation facilities.

Liu, *et al*. (1984) explored the visitor activities and recreation demands to Chitou. The basic data of visitors such as sex, age, education, etc. were analysed (Table 2.1). In addition, the primary studies of recreational activities taken and recreational experiences were estimated.

Table 2.1 The background information of the visitors to the Park in the previous study

Visitor Background	Options	% of respondents	Visitor Background	Options	% of respondents
SEX	Male	58.3	AGE	< 14	3.6
	Female	41.7		15-25	60.4
OCCUPATION	Students	44.2		26-35	20.8
	Agriculture	0.8		36-45	8.8
	Industry	8.5		46-59	4.9
	Business	15.7		>60	1.5
	Individual	6.3	EDUCATION	Elementary	5.2
	Others (none)	6.9		Junior H.	9.7
	Officers & Soldiers	17.6		High School	35.5
				University	49.6

(Data source: from Liu, *et al*. 1984)

The idea of ecotourism in the Chitou Park is relatively new. Some studies examining the relation between plant resources, their recreation value and the climate are in progress (Yao, *et al*., 1995). A study into the effect of recreation quality through the interpretation of conservation and education on visitors is also being carried out (Yao, *et al*., 1995).

2.2 Recreational Environmental Impact Studies

2.2.1 The Environmental Impacts of Trampling

Visitor exploitation of parks may cause environmental change to the topography, soil, drainage patterns, flora and fauna of the land (Wall and Wright, 1977; Pigram, 1985;

Zee, 1990). Additional impacts include waste material accumulation, and odour and noise pollution (Pigram, 1985). Trampling is the main cause of the recreational environmental impact and therefore, this section will focus on previous research into the impacts caused by trampling.

A. Effects on Soil

In Chitou, the impacts on the soil such as erosion and compaction is mainly caused by trampling, since in general, vehicles are prohibited from using the paths in Chitou. Soil degradation can be classified into compaction and erosion, both result in declining vegetation growth and biodiversity (Liddle, 1975a; Liddle and Hylgaard, 1981; Zee, 1990; Selman, 1992).

The most widespread effect of recreation comes from the feet of visitors creating a network of tracks and paths and areas of bare soil (Zee, 1990). Certain types of recreation activities cause more damage than others. Although estimating the decrease and composition change of vegetation requires long term study, the increase of the length of worn paths and bare soil can be measured quantitatively (Ittersum and Kwakernaak, 1977 cited by Zee, 1990).

B. Effects on Vegetation

The effect of trampling intensities on the recovery ability of vegetation was tested in a controlled environment by Liddle (1975a), Liddle and Greig-Smith (1974, 1975) and Bayfield (1979, 1980). In addition, the effect of trampling on the change of plantation species and frequencies has been modelled (Grime, 1973; Liddle, 1975b) and estimated (Liddle and Hylgaard, 1981; Pradham and Tripathi, 1983). A long-term trampling study on the environment carrying capacity was investigated by Burden and Randerson in 1972. Results from the studies have shown that though recreation brings impacts on the environment and ecology, some beneficial changes should not be ignored. Low intensities of trampling can stimulate plant growth and paths can break the forest canopy and allow more light in to stimulate the germination and growth of light- demanding plants (Pigram, 1985).

C. Other Impacts

Visitors cause impacts other than trampling, for example, littering and habitat distruction. Littering influences vegetation growth, species numbers and ground water in several ways (Zee, 1990). The scenic quality will also be directly affected by large crowds. The recreational or environmental carrying capacity can also be affected and causes spin-off impacts when visitor numbers or recreation use reaches a maximum.

D. Environmental Impacts In Chitou

The first environmental impact study in Chitou was carried out in 1989 and examined the effect of recreation in the Park (Liu and Huang, 1989). It was found that the soil, plantation, animals and water in the Park are all affected by visitors. The impact of camping sites and trampling on the plantations and footpaths was also studied (Liu and Huang, 1989). This effect was especially serious at the *University Pond*, camping areas, entrance areas and the path leading to the *Spiritual Tree*. The impact on birds, butterflies and squirrels caused by the disturbance and noise from visitors, and the habitat change was also examined. They pointed out that most impact was concentrated at several viewpoints and along trails. Three distinct zones of impact including the seriously impacted zone, the surrounding vulnerable zone and slightly affected buffer zone were assigned to viewpoints and the popular paths.

Cheng (1992) investigated the relation between forest soil erosion and the effect of green cover in Chitou. Results showed that forest soil erosion decreases as natural vegetation grows. In contrast, the establishment of farms such as tea or fruit gardens increase soil erosion. Bare land, man-made forests and bamboo plantations increase soil erosion also.

Huang (1989) indicated that large numbers of visitors had caused impact on litter production and water quality. The true extent of the effect has not yet be investigated.

2.2.2 Recreation Carrying Capacity

Wood (1987) related the trampling experience and visitor numbers to vegetational and environmental changes. A questionnaire survey of visitor distribution was conducted, and the result was mapped. A model was created using multiple regression for predicting the effects of variations in visitor numbers on the environment and recreation impact.

The effects of crowding and pressure on spatially located resources are seen to cause specific types of damage to vegetation, soil, air and water. The resulting damage is related to various methods of site management and strategic planning (Selman, 1992).

The term, 'carrying capacity' has been defined as 'the sensitivity or resilience of habitats to recreation disturbance and their recovery ability from damage' (Selman, 1992 and Harrison, 1981). The Countryside Commission (1970) defined 'Recreation carrying capacity' as 'The level of recreation use an area can sustain without an unacceptable degree of deterioration of the resource or of the recreation experience'. Both mentioned the concept of the maximum use of natural resources.

Recreational carrying capacity can be classified into four groups; ecological capacity, physical capacity, economic capacity and perceptual/social capacity (Goldsmith, 1983; Pigram, 1983; Stankey and McCool, 1989; Selman, 1992). The last term was defined by Glyptis (1991) as "the maximum level of recreation use above which there is a decline in the quality of the recreation experience from the point of view of the participant". As some researchers indicated that perceptual capacity is considered as the most complex aspect of capacity because it varies between individuals, according to their preferences to crowds, and it also varies for the same person from time to time and from place to place (Burton, 1974; US Bureau of Outdoor Recreation, 1977, Glyptis, 1991). In addition, it is the common point of other social studies, therefore, the result of statistical analysis is usually not as exciting as that from laboratory experiments.

Glyptis (1991) submitted the fifth capacity- landscape carrying capacity considering the size, configuration, terrain and vegetation, the effect on these distribution of visitors, in other words, their 'absorption ability' for visitors. Woodland, scrubs and sand dune environments with a variety of terrains are considered as having high-capacity landscapes. Chitou, is located in mountainous areas and as a result its physical environment and forested landscape offers the type of terrain which is able to 'absorb' more visitors. Such features provide the benefits for outdoor recreation development and the potential of a high landscape carrying capacity.

2.3 Application of Geographical Information System in Recreation Resource Management

2.3.1 A definition of Geographic Information System

A Geographic Information System (GIS) is a computer-based system designed for data collection and input, data storage, manipulation and analysis as well as data output and display (Burrough, 1986; Aronoff, 1989). Currently, its usage extends to a decision support system, a form of Management Information System (MIS), and a system with advanced geo-modelling capabilities involving the integration of spatially referenced data in a problem-solving environment (Hickin, *et al.*, 1991;

Aspinal, 1995). As Martin (1996) indicated, an important and fast-developing application field for GIS is that of socio-economic or population related studies. There is also growing manipulation of GIS for landscape (Haines-Young, 1993) and scenic beauty application management. With the former, GIS can combine public opinion such as questionnaires and publications with geographic scales to produce a computerised map which can simulate and predict consequences of various management decisions. Concerning the latter, aesthetic components can be linked to physical objects with definite locations, such as forests, geological structures or path networks. An introduction to GIS and IDRISI, a description of system types and adopted softwares (IDRISI) of GIS will be detailed in Chapter 3.

2.3.2 The development of GIS in Forest Management and Decision Making

Traditional mapping of landscape and natural resources uses spatial homogeneity units to classify landscape types. Mapping is completed with the Boolean analysis (1 and 0 index, 1 indicates that the pixel is the character desired while 0 indicates that is not) and overlay methods. Natural associations of vegetation and environmental variables were assumed (Ackerson and Fish, 1980; Phipps, 1981; Carroll and Morain, 1992). More recently, Kim (1990), Bara (1994) and Fox, *et al.* (1994) examined forest recreation planning and farmer decision making with the integration of interdisciplinary methods including statistics and GIS.

Smith, *et al.* (1995) studied the application of GIS in forest policy. Social factors including social organisation, and power and regulations were also examined. In addition, systems of ecology and economy (including of the attitudes, philosophies, values and behaviours which people in various social groups developed) were interrelated with GIS to investigate the effect of land use decisions. Results suggested that "for more effective forest decision making, forest managers also need to relate social and value systems to forest land use".

A further study involving the combination of socio-economic data with environmental analysis and GIS was carried out by Mathieson and Wall (1982) and Maguire *et al*. (1991). The socio-economic data included survey data, population, employment, transport networks, planning and the other types of designated land uses. The impact of ecotourism in particular geographic areas was also examined. As Aspinall (1995) indicated, "the use of a combined environmental/ socio-economic database for geographical analysis in environmental issues is increasing as sustainable development becomes a greater priority and as awareness grows of the inter-dependence of socio-economic and environmental systems".

A Visual Resource Management System was adopted by Bishop and Hull (1991) to provide an effective mechanism to present results of landscape environment change for decision makers. This was achieved by defining the visual resources, investigating the impacts, examining the predictors and building impact prediction models to integrate all these variables. In their studies, physical variables (relief, water, etc.), ephemeral variables (i.e. rainfall, quality of sunset, wildlife exposure- were mapped as probabilities) and human variables (anticipated activities, user population) in terms of scenic beauty, were all considered as mappable characters. In addition, the psychophysical methods, GIS-based modelling, video-imaging technology and expert systems were all used to complete the task.

2.3.3 GIS in Amenity and landscape studies

Selman (1992) investigating landscape ecology, evaluated the applicability of selected test criteria to landscape planning for a farm woodland. Account was taken of the general landscape ecological principles which provide a rationale for the production of the test planning. A GIS model was proposed and traditional map overlay was manipulated for the production of a final map. Another similar study was carried out by Haines-Young *et al.* (1993). The geometric properties of landscape and landscape components were searched with GIS techniques (Haines-Young *et al.* 1993).

The method of recreation perception mapping applied to wilderness areas in terms of artifactualism, remoteness, naturalness and solitude was explored by Kliskey (1994). Two approaches were adopted for this study. The first, was an intuitive spatial-perceptual approach while the second, was a more sophisticated multivariate approach. The latter employed multivariate statistical techniques and introduced a weighting system in the overlay mapping stage. This approach is suggested by Kliskey (1994) for providing a finer level of differentiation of spatial analysis.

In addition to perception mapping, the quantification and mapping of landscape complexity is essential for amenity management and recreational planning. As Monmonier (1974) illustrated that both cartographic (graphic or digital) and psychological studies had identified landscape complexity as an important influence on visual pattern recognition. Both studies applied a fragmentation index as a standardised measure of the number of landscape types on the map base. This measure can now be integrated with IDRISI for the final map representation of the landscape diversity.

2.3.4 GIS in Ecological/ Natural resource management and impact studies

The use of GIS as an environmental resource management tool is becoming increasingly widespread. In the study of environmental and ecological relationships, the principle of landscape ecology is often considered in conjunction with the application of GIS (Haines-Young *et al.* 1993).

McKendry, *et al.*, (1992) using the Universal Soil Loss Equation (USLE) (from the United States Department of Agriculture Handbook) studied soil loss in the tropical forests of northern Thailand. The equation is based on indices of soil, vegetation, climate (rain- fall), terrain and management factors (conservation practice factors). The study found that the result of USLE is especially true when the equation is refined for local conditions by experts using local data and when actual measurements of soil loss can be used to calibrate the indices produced by the equation. Several modules of IDRISI were employed to map and analyse the factor images for predicting future areas of deforestation and the affect of this change on soil loss.

GIS can be applied for environmental management and nature conservation with the exploration and analysis of ecological and environmental relationships based on geographic scales (Aspinall, 1995). In addition, the ability to predict possible impacts of environmental changes within a computer environment is especially useful.

The maintenance of biodiversity is another important objective for nature conservation. Some geographic features of biodiversity can be analysed, measured and planned using GIS (Bridgewater, 1993; Walker and Faith, 1993; Aspinall, 1995). As Aspinall (1995) mentioned, geographic data are important in biodiversity assessment and species lists for sites. In addition, GIS is important in modelling species distribution and can represent their relative contributions of sites to diversity at different geographic scales.

2.3.5 GIS in Route planning

The traditional planning for forest road location can be split into the following steps (Allal and Edmonds, 1977; FAO, 1977; Hogan, 1973):

(i) to find the alternative routes;

(ii) to evaluate the alternative routes;

(iii) to select the best and meet the target of minimum cost and maximum benefit.

This planning is based on economic considerations. Nieuwenhuis (1986) defined the routes for road construction between any pair of the nodes (two points on a map) by the least cost path.

GIS is increasingly used in route selection. The techniques of GIS systems and operations research have been considered effective in routing forest road networks (Turner and Miles, 1971; Morofsky, 1977; Nieuwenhuis, 1986; Kobayashi and Nitami, 1992). Clayson (1996) used GIS as a tool in rights-of-way management. This study included a Digital Terrain Model (DTM) of the landscape, altitude, slope and aspect. In addition, the length of the network, land cover and soil types were all combined to predict the likely areas of erosion in route planning as well as the shortest route between two points on the network. In a study of planning forest road networks by Tan (1992), GIS techniques were used for manipulating the spatial data and the shortest distance was identified. In addition, environmental and ecological factors were considered.

Computing and mapping visible areas from a viewing point can be undertaken with certain GIS packages which employ digital elevation models (DEM). The process is known as Viewshed. Fisher (1992) found the Viewshed to be "a common capability of a GIS packages". The usual viewshed operation within a GIS presents the user with a Boolean product, 1 indicates that the pixel is within the viewshed while 0 indicates that it s not.

2.3.6 Statistical Application In GIS

LaGro and DeGloria (1992) employed multivariate regression analyses and GIS to integrate land use and land cover data (forest, agriculture, vacant, wetland and urban) with other ancillary demographic and physiographic spatial data. The relationships between the variables were modelled in a series of weighted least squares regressions employing data spatially aggregated by general soil maps.

In a similar study, Schneider and Robbins (1995) applied multivariate statistical analyses to evaluate and distribute the casual factors of landscape and their distribution. A number of packages, both statistical and geographical, were employed to model the contribution of various topographic conditions (variables) to resulting landscape types.

Coker and Capen (1995) studied the distribution of cowbirds in a forest in New England in an attempt to understand the effect of forest disturbance on the occurrence of this species. Logistic Regression was adopted to develop predictive models. The variables described area of the patch, distance to the closest disturbance patch and number of livestock areas within 7 km of the patch. A grid-based GIS procedure was employed to map the probability of cowbird distribution which was obtained from the prediction model in disturbance patches across the study areas.

Wiber-Carlson and Schroeder (1992) built a model using multiple regression to predict the visitors' enjoyment of a trail environment. Physical features in the scenes such as amount of trees, shrubs and the degree of openness, etc. obtained from photographs were the predictors. The coefficients of these physical features in the model were used as the weightings to produce a final map which represented trail enjoyment using GIS.

2.3.7 GIS studies in Chitou

Chiao, *et al.* (1988) studied the establishment of a forest resource database of Chitou Tract. Terrain, land use and forest type files were created by digitising the aerial photography data. Other physical feature data including soil and geology were digitised based on the existing paper map. Four database systems including bamboo forest land classification, timber volume computation, land rent calculation and plantation environmental factors determination were carried out to help solve the problems of forest management.

Cheng (1992) studied the feasibility of the use of GIS to examine forest soil erosion in Chitou and surrounding areas. The forest was characterised into homogeneous units based on site classification. The potential and actual soil losses were compared with the aid of the Universal Soil Loss Equation. The erosion hazard was classified into 5 levels. Using GIS, results showed that 'the current soil erosion' in Chitou is 'very severe'. Chen found that the potential soil erosion in the area could be improved to moderate from very severe with proper management (i.e. more green cover). Cheng indicated that the application of GIS is cost-effective and a feasible alternative when compared with traditional methods.

2.4 Economic Evaluation of Natural Resources Management and Recreation Development

2.4.1 Economic evaluation of recreation demands

Contingent Valuation Method (CVM) is the main method for evaluating non-market goods in monetary terms. As Edwards-Jones *et al.* (1995) mentioned, the essence of this technique is that members of the public are asked what they are willing to pay (WTP) for a specific good, or willing to accept as compensation for the removal of that good. The major advantages of utilising CVM over other valuation methods, such as travel cost and hedonic pricing, relate to its flexibility and its ability to measure non-use values. CVM has been widely used to value scenic beauty (Brookshire *et al.*, 1976) and landscape (Willis and Garrod, 1991; Drake, 1992).

Keith (1996) studied wilderness protection designation using CVM to evaluate the non-market value of multiple use management (i.e. grazing, mining and recreation, etc.). For the study of water resources and outdoor recreation, results allow comparison of WTP for trip length and showed increasing trip length decreases marginal benefits. Results also showed that the visitor would be willing to pay more for fewer encounters with other tourists groups (Rollins, *et al.*, 1995). These results confirm Gilbert's study on increasing WTP for less visitor density (1994). In his study, visitors' perceptions and their attitudes towards a national wildlife refuge were explored. He indicated that there was a positive relationship between WTP for refuge protection and a positive experience, as well as between WTP for wildlife protection effort and limiting visitors' numbers.

The validity and reliability of CVM were assessed with a comparison of on-site users, off-site users and non-users by Whitehead, *et al.* (1995). Results indicated that incomplete information affects the validity and reliability of WTP for the allocation change of natural resources.

Curry (1987) indicated, one of the most significant shortcomings of the cost-benefit study was that it didn't take into account the distributional consequences of public investments. He then attempted to integrate explicit factors into a cost-benefit model for recreation, and applied the model to three recreation sites in England.

2.4.2 The economic value of natural resource conservation

In addition to evaluation of recreation, CVM is used widely for valuing non-market goods including environmental amenities, natural conservation, cultural heritage conservation, etc. (Kooten, *et al.*, 1996; Lockwood, *et al.*, 1996; Mortimer, *et al.*, 1996). Furthermore, CVM can be applied to the evaluation of water resources (Keith, 1996; Wegge, *et al.*, 1996), endangered species preservation (Loomis and White, 1996), biodiversity preservation (Holl, *et al.*, 1996) and soil conservation (Pitt, *et al.*, 1995). Willingness to pay (CVM) for a new national park for nature tourism was compared with the travel cost method from a rain forest conservation project by Mercer, *et al.* (1995). In another related case study, Leon (1996) used CVM to measure willingness to pay for preserving the landscape of a group of national parks. The results showed that the WTP level was not significantly different between non-users and regular users.

CVM was also used to draw out financial willingness to pay bids for an ecological evaluation of a site. Results suggested that the use of CVM for valuing ecological goods produces different results from traditional ecological assessments (Edwards-Jones, *et al.*, 1995).

2.4.3 Evaluation of Footpath Construction

There are a number of factors to be considered while planning a forest road network. These factors can be categorised as; forestry activities, ecological factors, plant and wildlife resources and biodiversity, environmental factors (terrain, soil and weather, etc.), construction and maintenance and non-forestry use (recreation and public use, etc.). Other constrain include ownership, government policies and regulations (Allal and Edmonds, 1977; Minamikata, 1984; Kantola and Harstela, 1988). To assess all the above factors, quantification has be normally in terms of cost and benefits (Tan, 1992).

When planning the construction of a low cost unsurfaced forest road, the importance and evaluation of criteria including road width, junction with public access road, road across sections, gradients and bridge approaches were highlighted by Jones (1994).

The minimum total cost of terrain transportation, road transportation, road construction and maintenance while planning a forest road network was targeted and invested by Tan (1992). The road location, road network density and road quality were based on consideration of the environment and ecology of the area. Average terrain transportation distance and an exploitation index were additional factors included by Sakai (1983). Tan (1992) pinpointed that the economic evaluation in terms of costs and benefits became the most important when alternative routes for a road were available.

The total cost of road building for forestry include construction, repair, maintenance and labour transportation costs (Yamamoto, 1991; Sawaguchi, *et al.*, 1995). In addition, there are land costs and wood transportation costs (Sawaguchi, *et al.*, 1995). Furthermore, characteristics including road surface, and stability have been studied, and considered in low cost forest road construction (Yamamoto, 1991). The effect of reducing the maintenance cost of a forest road surface was estimated by Kondo, *et al.* (1990). The influence of rain fall and slopes to surfacing was considered in their research. They indicated road surfacing reduced the maintenance costs to a similar extent to the reduction given by modifying road gradients. In addition, this effect of surfacing was better on hills than in the valleys.

2.4.4 Economic evaluation of natural resources and recreation management in Chitou

Previous research concerning economic evaluation related to the resource or recreation management of Chitou is limited and those studies that do exist have focused on the income variation caused by recreation management (total income and income source). For example, Huang and Liu (1987) indicated the gross-income generated from the management of Chitou Forest Recreation Area had increased to a much higher level than the income from timber production. The 'ticket income' and 'timber income' were 49 percent and 23 percent of total income of Chitou (Huang and Liu, 1987). In addition, the promotion of the local economic activities and the provision of increased employment opportunity from the recreation development were studied (Huang and Liu, 1987). Lou and Fung (1983) adopted a Gross Expenditure Method to study the amount which visitors spent on visiting Chitou. Results showed that on average, £19.80 was spent each visit on items including ticket, food, accommodation and other fees. From the results of Huang and Liu (1987), visiting Chitou took £5 for one person per day and can increase by £480 income for local resident per person per year. There are differences between the results of Huang and Liu (1987) and, Lou and Fung (1983). Lee (1991) examined local economic change under the development of Chitou recreation management. He cited, "the total industrial outputs, total income and employment opportunity increases from recreation development."

CHAPTER 3. OVERVIEW OF METHODOLOGY

3.1 Overview of Study

This study will examine the hypothesis that a GIS analysis system can be integrated with visitor recreation preference management for a National Park and used as a natural resource and recreational management tool. Recreation preferences (enjoyment and landscape feature) and, resource spatialisation will be identified, quantified and integrated with the use of GIS. The study procedure is summarised in Figure 3.1.

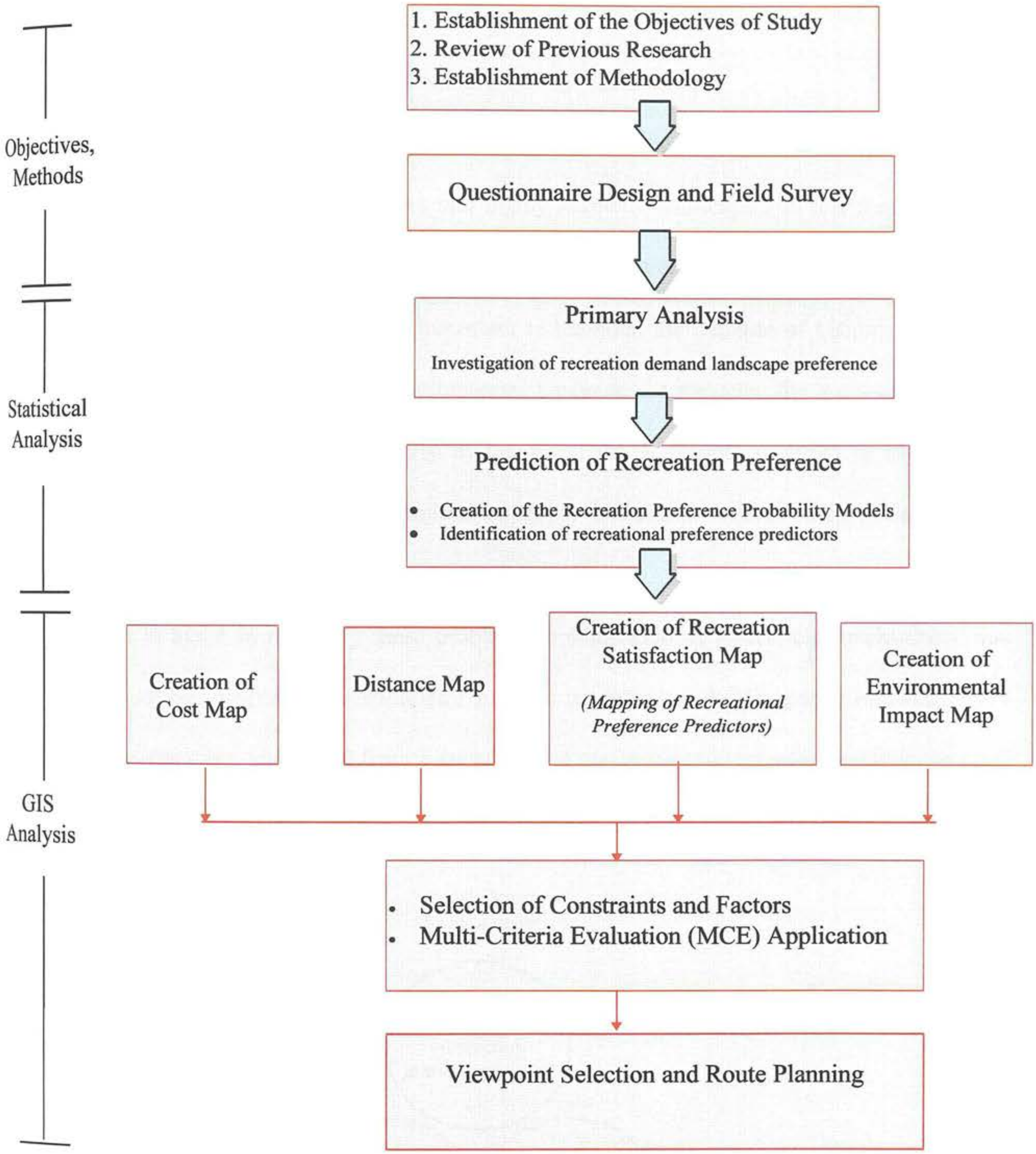


Figure 3.1 Summarised study procedure

3.2 Recreation Management And Carrying Capacity Studies

3.2.1 Overview of Study and Questionnaire Survey Techniques

The high population density of Taiwan leads to a shortage of recreation space. Chitou, contains abundant wildlife resources and highly aesthetic landscape and this means that the potential for recreation development is high. Although the entrance fee has become the main source of income to the Park, it is important to maintain the increase of visitors by serving and satisfying their recreation requirements. Under such pressure, the park management needs to maintain recreation quality in the Park. An additional problem is ensuring all recreational activity is done with minimal impact to the natural resource in the Park.

In order to assist in resolving these problems, a simulation of recreation development was carried out by integrating questionnaire surveys, modelling and GIS spatial analysis. Three main aspects were considered from a set of natural resources and recreation study issues, and three questionnaires were subsequently designed to explore the above problems (Figure 3.2).

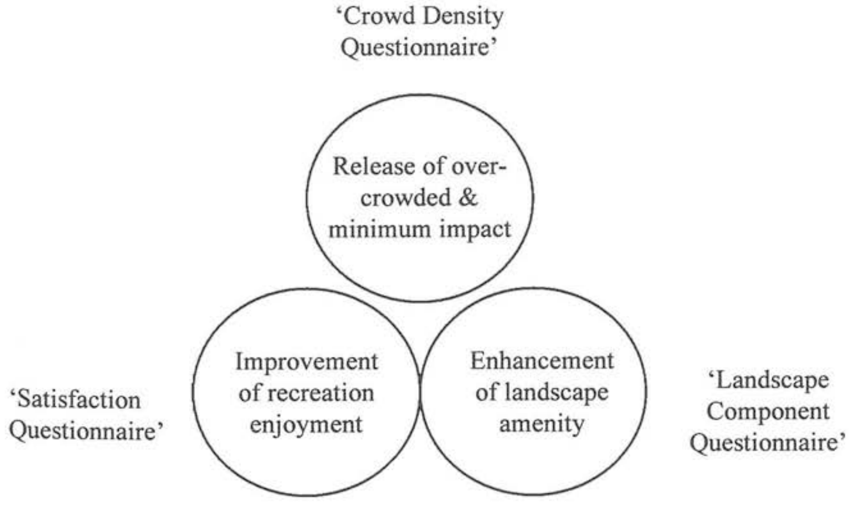


Figure 3.2 The three problems and the related three questionnaires

The carrying capacity of the Park discussed here includes recreational, environmental and physical factors. Three questionnaires were designed from the consideration of these aspects as follows:

(1) Assessment of visitor satisfaction with recreational facilities of Chitou ('Satisfaction Questionnaire') (Appendix A)

(2) Assessment of visitor reaction to crowd experience of Chitou ('Crowd Intensity Questionnaire') (Appendix B)

(3) Assessment of visitor reaction to landscape components in Chitou ('Landscape Component Questionnaire') (Appendix C)

Attitudes to environmental conservation (represented by willingness to pay) and various economic issues in Chitou, including evaluations of conservation value, amenity value and the potential for recreation development (popularity and its importance to visitors), were included in the 'Satisfaction' and 'Crowd Intensity' Questionnaires.

Interviews were taken at two popular viewpoints in the Park, *University Pond* and *Spiritual Tree*, during the peak season and at peak times for visitors in July and August of 1995. Interviewers attempted to question one in five visitors selected at random. Before the interviews began, each respondent was given a brief background and objective of the study. Interviewers were told to avoid leading interviewees. A total of 18 students assisted over a 6 week period, each being involved for a week. Each of the 3 questionnaires took no longer than 20 minutes to complete, and in order to prevent lack of attention, each interviewee was asked to answer only one of the three questionnaires. The students were changed weekly to avoid any interview bias.

3.2.2 Questionnaire Design

All questions were answered as one of the 7 following types;

Type 1 : yes/no answers;

Type 2 : which option the respondent most preferred ('one from many');

Type 3 : 5 levels (1 to 5; least preferred to strongly preferred);

Type 4 : 11 levels (on the -5 to +5; Scale where -5 means strongly dislike, 0 related to an undecided view and 5 to a strong preference);

Type 5 : 100 percentage range (0-100%, recoded into 5 levels evenly during analysis);

Type 6 : 'open answers';

Type 7: 9 levels ('*5 4 3 2 1 2 3 4 5*'; two ends mean two extremes and 1 means undecided or neutral).

3.2.3 Recreational Satisfaction Preference (Satisfaction Questionnaire)

In order to summarise the questionnaires, each question was given a 'variable name', and the variables were grouped into 'issues'. Initially visitors were queried on their background, with Type 6 question design. The 11 questions covering the visitor background topic are shown in Table 3.1(a).

Table 3.1 The 53 Variables in Satisfaction Questionnaire. (a) Part I. Variables in Visitor Background Part (The same questions were used in all three questionnaires).

Variables	**Brief Description of Variables**
1. SEX	Sex
2. ADDRESS	Where are visitors from?
3. TRANSPORTATION TIME	One way spent for transportation time
4. TRANSPORTATION FEE	Travel fee paid for single journey
5. EDUCATION	Education levels
6. AGE	Age levels
7. INCOME	Monthly income
8. VISIT TIMES	Visited times to the Park
9. DURATION	Stay period
10. TOTAL VISITORS	Company persons
11. CHILDREN	Children numbers

The Satisfaction Questionnaire consists of 20 questions and aimed to examine the level of visitor satisfaction to the Park (Appendix A). Two methods of questioning were involved: textual questions and questions which related to colour photographs ('photo questions'). Preferences for viewpoints, plantations, landscape diversity, willingness to pay (WTP) and information needs were all issues examined. With the exception of three questions, the questions related to these issues were in text format. Preferences for landscape diversity from viewpoints, landscape (plantations) arrangement along pathways and forest combination (pure and mixed forests) were presented in photographic format (Appendix A). The 20 questions in questionnaire 1 have been summarised in Table 3.1(b).

Table 3.1 The 53 Variables in Satisfaction Questionnaire have been grouped into 12 ISSUES and visitor background part for the purpose of illustration. (b) Part II. Variables in the Main Part

Issues	Variables	Brief Description of Variables
1. Park Preference	Visitor Choice	factors on which park to visit?
	Park Preference Order Chosen Reasons	park preferences assuming same distance and Entrance Fee Why?
	Reason For Visit	main attraction to the Park
	Park Impressions	first impressions of the Park
2. Viewpoints/ Social Facilities Preference	Favourite Viewpoints	favourite viewpoint in the Park
	Least Favourite Viewpoints	least favourite viewpoint in the Park
	Enough Viewpoints?	Are there sufficient viewpoints?
	Social Facility Satisfaction If not, why?	satisfaction levels with the social facilities -
3. Facility Availability	Facility Amount	enough facilities?
	Facility Required	facilities would like to be built
4. Visitation	Visit Frequency	-
	When Next Visit	What will be the next visit time
5. Plantation Preference	**preferred plantations-** Forest 1- conifers Forest 2- broad-leaved Forest 3- mixed Forest 4- bamboo Forest 5- natural Forest 6- lawn	 man-made conifers man-made broad-leaf forest man-made mixed forest bamboo natural forest forest rest lawn
6. Forest Composition Preferred	**preferred forest composition-** Pure Forest Mixed Forest	(Photo Questions)
7. Colour Preference	Season Colour Preference	-
	Red, Yellow, Light Green, Orange, Dark Green, Brown, Extent of Brightness	colour ratio preferences in a landscape
8. Landscape Preference	Landscape 1: simple Landscape 2: less simple Landscape 3: less complex Landscape 4: complex	landscape diversity preferred (PHOTOS)
	Plantation Arrangement Preference	the most and least favourite plantation arrangement along footpaths (PHOTOS)
9. Information Required	Information Levels	information about this site and viewpoints needed
10. Fee Issues	Ticket Fee	entrance fee paid
	Price Reasonability	reasonability of current entrance fee
11. WTP issues	Viewpoints	WTP for more/better viewpoints
	Entrance Fee	extra fee would pay?
	Conservation	extra fee (WTP) for improved conservation
12. Transportation	Maximum Transportation Length	Maximum transportation as below?

3.2.4 Recreational Crowd Density Preference (Crowd Intensity Questionnaire)

The second Questionnaire (Crowd Intensity Questionnaire) dealt with visitor preference in relation to crowd intensity and visitor distribution in the Park. The study included questions about the crowd intensity perception, preferences for pathway numbers and types, visitor distribution in the study area (visiting routes), visit interests and preferred activities. WTP for a reaction to crowd density was also examined. Both text questions and 'photo questions' (visitors' favourite path type) were included. TYPE 2 ('one from many'), TYPE 4 (11 levels) and TYPE 6 ('open answers') were three question types used. In addition to the visitor background questions, the variables examined in this questionnaire are listed in Table 3.2.

Table 3.2. The 77 variables in Crowd Density Questionnaire Study. They are grouped into 8 ISSUES for illustration reason.

Issues	Variables	Brief Description of Variables
1. Interview Background	Interview Site	interview sites
	Visitor Density	visitor density while interview progressed
2. Crowded experience	Crowded Experience	-
	crowded viewpoints- Crowd View 1- Red Mansion Crowd View 2- Campsites Crowd View 3- Gingko Plantation Crowd View 4- The Great Spiritual Tree Crowd View 5- University Pond Crowd View 6- The others	-
	Maximum Number People	maximum number of people tolerable along paths
	Improvements (5 variables)	best improvement for decreasing crowds?
3. New Path Zone	Block Identification (3 variables)	Identification of the block for new footpaths (see Footpath Map)
4. Path preference/ selection	Path Likes	footpath material preferred
	Present Footpath Satisfaction	satisfaction with the footpaths (Yes/No)
	Routes Visited (23 variables)	(see Footpath Map)
	Reasons for Route Selection (7 variables)	-
	Preferred Paths (23 variables)	(see Footpath Map)
5. Favoured features along walks	Features Liked (11 variables)	features preferred along walks
	Features Not Liked (8 variables)	features less preferred along walks
6. Favoured activities along walks	Activities Preferred (6 variables)	Favoured activities along walks
7. Facility preference / improvement	Footpath Design	footpath design preference
	New Facilities	new public facilities preferred
	Signposts	signposts issue (amount/ clear)
8. WTP for lower crowd densities	Reduce Crowd Density	YES/NO
	Reduce 50 % Reduce 25 %	WTP for less crowd density 11a. 1/2? 11b. 1/4?
9. Maintenance Entrance Fee	Loss of Visitors	As density increase, what proportion of visitors will be put off.

To explore the problem of visitor distribution and investigate new path development (ISSUE 3 and 4), three questions were designed to examine where visitors had been, which paths they preferred and whether they would like to see a greater number of available routes. The current path system was sub-divided into 23 pathway sections and a number 1-23 was assigned to each. The pathway sections were mapped and presented to visitors while they were being questioned on their visited and preferred routes (Appendix H). The current path network map was also split into 11 blocks (zones) to help identify locations where new paths were required (Appendix H).

The 'Crowd Intensity Questionnaire' was performed at two viewpoints: *the University Pond* and *the Spiritual Tree* (Figure 1.2). The number of visitors around each interviewing site was counted every hour, this was used to represent the visitor density recorded on the questionnaire at a particular site and time.

3.2.5 Landscape Component Preference (Landscape Component Questionnaire)

Landscape amenity was considered here due to its growing importance in the Park. In recent times, some improvements have occurred such as the planting of ornamental tree species in small areas instead of the traditional conifer plantations. In order to explore visitor preference to landscape, a Landscape Component questionnaire (Appendix C) was completed using colour photographs. Two aspects were examined; Landscape Themes and Landscape Scales.

In order to examine preference to landscape themes, 6 sets of landscape theme photographs (*Footpath Surface Preference, Forest Preference, Crowd Density Preference, Colour Preference, Presence/Absence of Bridge* and *Water Features, Forest Structure Preference*) were presented to interviewees. Most of the photographs were of landscape features in Chitou taken in the summer of 1994. The remaining photographs were taken from Chitou and other publications (Lucas, 1991; The Experimental Forest, N.T.U., 1979, 1993a, 1993b). Visitors were asked to point out their favourite photograph from each of the 6 sets of photograph presented (Table 3.3a). In addition, visitors were asked to assign a score for each of the photographs.

Table 3.3a Variables in the Landscape Themes (Photograph Survey)

VARIABLES	Brief Description of Variables
	The favourite photograph of each of the 6 photograph set
Footpath Like	1. Photograph set 1 (four kinds of footpaths) (A,B,C,D)
Forest Composition Like	2. Photograph set 2 (conifer/broad-leaf trees/mix forest/bamboo forest) (A,B,C,D)
Crowd Like	3. Photograph set 3 (many people/less people/no people) (A,B,C)
Colour Composition Like	4. Photograph set 4 (green/colourful) (A,B)
Bridge Like	5. Photograph set 5 (water bodies; bridges/ no water bodies; bridges) (A,B)
Stand Structure Like	6. Photograph set 6 (multiple-storied/single-storied forest) (A,B)
	Continue the <u>above</u>, the preference to each photograph in each photograph.
Footpath Like Extent (4 variables)	1. Photograph set 1 (A,B,C,D) (11 SCALE)
Forest Composition Like Extent (4 variables)	2. Photograph set 2 (A,B,C,D) (11 SCALE)
Crowd Like Extent (3 variables)	3. Photograph set 3 (A,B,C) (11 SCALE)
Colour Composition Like Extent (2 variables)	4. Photograph set 4 (A,B) (11 SCALE)
Bridge Like Extent(2 variables)	5. Photograph set 5 (A,B) (11 SCALE)
Stand Structure Like Extent (2 variables)	6. Photograph set 6 (A,B) (11 SCALE)

The second aspect (Landscape Scale) was divided into 2 sections, Landscape Feature Preference and Landscape Psychological Preference. Twelve colour photographs different from above, were classified evenly into two groups of 'Large Scale' and 'Small Scale'. In the study of Landscape Feature Preference, on choosing 2 photographs (like and dislike) from both groups of 'Large Scale' and 'Small Scale', respectively, visitors were then asked to select a decisive landscape factor for each of their chosen photographs, from a list of 15 landscape feature pairs (Table 3.3b).

Table 3.3b The variables in the Landscape Feature Preference to Large Scale photographs in Landscape Scale study. The same design applied to the Small Scales (The variable names are shown in parentheses).

Variables	Brief Description of Variables
Most favoured photograph in Large Scale (Most favoured photograph in Small Scale) Least favoured photograph in Large Scale (Least favoured photograph in Small Scale)	The most and the least favourite photograph in LARGE SCALE
Preferred Large Scale Features 1 (Preferred Small Scale Features 1) Preferred Large Scale Features 2 (Preferred Small Scale Features 2) Preferred Large Scale Features 3 (Preferred Small Scale Features 3)	**The preferred feature for the most favourite photograph in LARGE SCALE from 15 options** 1. water body / no water body 2. bridge / no bridge 3. good / bad arrangement of scenery 4. good / bad design of footpaths 5. material of footpaths-- like/dislike 6. the diversity of landscape / boring 7. colourful / plain 8. conifers/ broad-leaved trees 9. natural features / unnatural features 10. mountains / plain 11. sky / no sky 12. eyesore / no eyesore 13. brightness / darkness 14. large scale / small scale 15. the others ________________
Least Preferred Large Scale Features 1 (Least Preferred Small Scale Features 1) Least Preferred Large Scale Features 2 (Least Preferred Small Scale Features 2) Least Preferred Large Scale Features 3 (Least Preferred Small Scale Features 3)	**The least preferred feature for the least favourite photograph in LARGE SCALE from the same 15 options above.**

For the study of Landscape Psychological Preference, visitors were asked to mark from a list of 15 comparison pairs of landscape perception for the same chosen 2 photographs (the most and the least favourite photographs). This was done for the two Scales (Large and Small) of photographs, respectively. Different from the other 6 question types previously mentioned, 9 scales was applied to each pair among the 15 comparison pairs (Table 3.3c) ranged from preference scales +5 through 1 to +5 representing the two extremes with 1 in the middle showing no preference (neutral) (Appendix C). For example, if visitors mark of +5, preferred the *Bright* feeling to a photograph (*Bright 5 4 3 2 1 2 3 4 5 Dull*), it meant that they liked the chosen photograph bright rather than dull.

Table 3.3c The Landscape Psychological Preference in Large Scale in the Landscape Scale study. For the most and the least favourite photographs, the same 15 questions were applied. The same questions were applied to the Small Scales also (The variable names for Small Scales are shown in parentheses).

Variables	Brief Description of Variables		
	The 15 feelings to the most favourite photographs in LARGE SCALE (9 levels)-		
Scale in Large (Small) Photograph	1. Large scale	5 4 3 2 1 2 3 4 5	Small scale
Commonness in Large (Small) Photograph	2. Common	5 4 3 2 1 2 3 4 5	Unusual
Angularness in Large (Small) Photograph	3. Angular	5 4 3 2 1 2 3 4 5	Rounded
Brightness in Large (Small) Photograph	4. Bright	5 4 3 2 1 2 3 4 5	Dull
Hardness in Large (Small) Photograph	5. Hard	5 4 3 2 1 2 3 4 5	Soft
Openness in Large (Small) Photograph	6. Open	5 4 3 2 1 2 3 4 5	Close
Variedness in Large (Small) Photograph	7. Varied	5 4 3 2 1 2 3 4 5	Monotonous
Naturalness in Large (Small) Photograph	8. Natural	5 4 3 2 1 2 3 4 5	Man-made
Colourfulness in Large (Small) Photograph	9. Colourful	5 4 3 2 1 2 3 4 5	Colourless
Scenicness in Large (Small) Photograph	10. High scenic	5 4 3 2 1 2 3 4 5	Low scenic value
Interesting in Large (Small) Photograph	11. Interesting	5 4 3 2 1 2 3 4 5	Boring
Obviousness in Large (Small) Photograph	12. Obvious	5 4 3 2 1 2 3 4 5	Mysterious
Beautifulness in Large (Small) Photograph	13. Beautiful	5 4 3 2 1 2 3 4 5	Ugly
Peacefulness in Large (Small) Photograph	14. Peaceful	5 4 3 2 1 2 3 4 5	Crowded
Pleasantness in Large (Small) Photograph	15. Pleasant	5 4 3 2 1 2 3 4 5	Unpleasant

(The same 15 comparison sets designed for the least favourite photographs in both large and small scales).

3.2.6 Environment Conservation

Environmental conservation was explored through questionnaire surveys and secondary data available from the Park headquarters. Information such as the importance of wildlife to visitors, wildlife resources of Chitou and their distribution were investigated. The results are especially important in development planning so that key conservation areas can be maintained free of visitor disturbance.

Willingness to pay for conservation was investigated in the 'Satisfaction Questionnaire' (Table 3.1(b) ISSUE 11). Visitors were presented with Type 2 questions ('one from many'; numbers of monetary options were offered in this WTP answer list) and asked to choose how much they would be willing to pay for improved conservation. In a few questions, visitors were also queried as to whether they were attracted by (or felt impressed by) the conservation and natural features in the Park ('Satisfaction Questionnaire'). Information (attributes and locations) about wildlife including rare trees, birds, butterflies and frogs were collected from publications and used for mapping (the establishment of visit areas and conservation areas).

3.2.7 Economic aspects

The recreation value of Chitou was explored in questionnaires A and B ('Satisfaction' and 'Crowd Intensity' Questionnaires) and related economic literature sources (refer to Chapter 2, Section 2.4). In questionnaire exploration, the level of the entrance fee and WTP for recreation were examined. Willingness to pay was the method used to investigate economic value of non-market products including the values of viewpoints (landscape amenity), the value of conservation and lower crowd intensity. In addition, the number of visitors and historical variation were examined with the aid of the Park manager. Literature reviews relating to Park economic aspects including income from recreation, the economic variation in the around villages and townships (refer to previous research section 2.4 in the last Chapter) were all examined.

3.3 Modelling of Recreation Preferences

Two questionnaires were designed to investigate the extent of recreation satisfaction and the level of the recreation carrying capacity. Regression analyses including Linear Regression Analysis (LR) and Logistic Regression Analysis (LRA) were used to highlight a selection of the decisive variables which were able to examine both recreation issues. Using Factor Analysis (FA) to reduce the number of variables and subsequently running Linear Regression was a third modelling option. FA was adopted to compare the results obtained from LR and LRA. The two best fitting models (one from each of the 2 questionnaires) were chosen. GIS was then used to identify the spatialisation of visitor preferences. Details of the modelling approach are given in Figure 3.3.

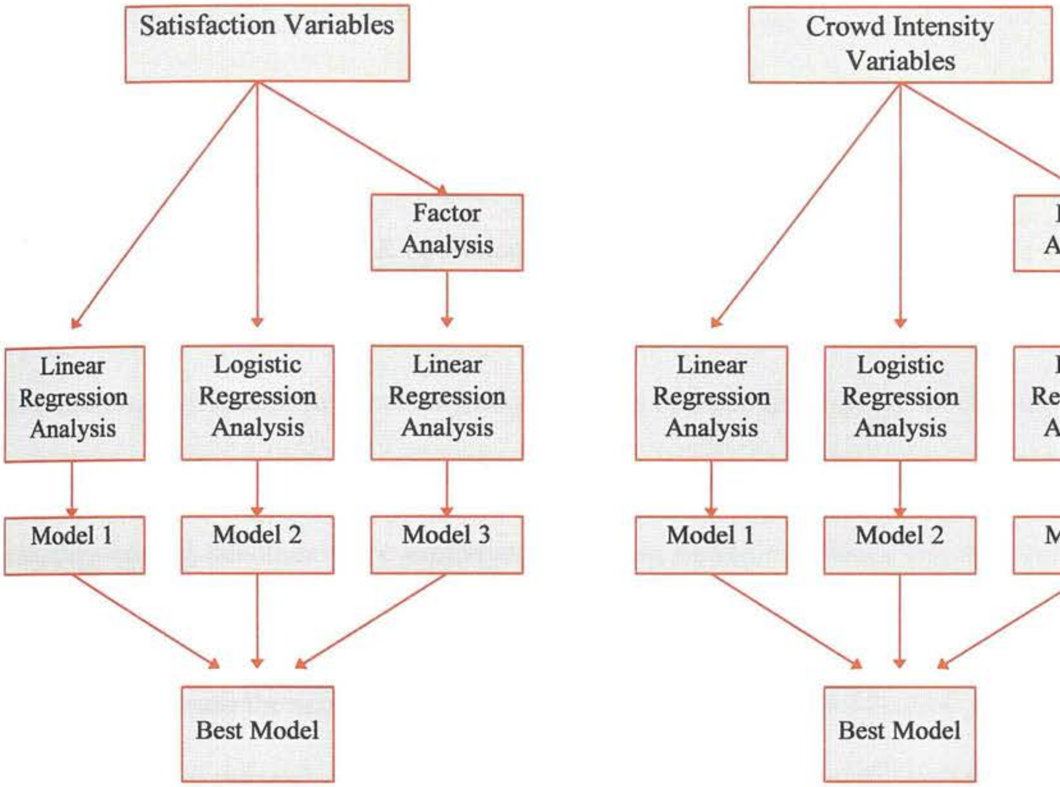


Figure 3.3 Diagram of the establishment of 'Satisfaction' and 'Crowd Intensity' models-methodology approach.

3.3.1 Linear Regression Analysis

Linear Regression Analysis (LR) was used to investigate the separate linear association of the variables in both the 'Satisfaction Questionnaire' and the 'Crowd Intensity Questionnaire'. By identifying the decisive independent variables of visitor satisfaction and crowd assessment, and their linear relationship, both the Satisfaction and Crowd Intensity perception of visitors to Chitou were predicted. The Stepwise method for variable selection was adopted.

3.3.1.1 LR Data Preparation

Using two methods, LOG and positive SQRT transformation, the non-continuous variables of the Satisfaction Model and the Crowd Intensity Model were transformed to format the dependent variables into the LR operation.

In addition, to increase the accuracy of prediction of the 'Satisfaction' questionnaire, some independent variables were recoded into two categories (0 and 1) manually and dummy variable coding schemes were employed for those variables. The SPSS dummy variable coding schemes were applied for the other independent variables (SPSS, 1993). There was no need to increase the accuracy of the 'Crowd Intensity' Questionnaire (the R square figures were accepted in the trial run), and as a result, the dummy coding schemes did not have to be repeated. The Stepwise variable selection method was conducted for both questionnaires. Variables with an F value of less than 0.05 were included in the model. If the F value was greater than 1, the variable was removed. The details of Linear Regression are described in the LR section in Chapter 5 (Section 5.3).

3.3.2 Logistic Regression Analysis

A less widely used alternative to LR, Logistic Regression Analysis, was included in this study to compare the prediction capability of the resulting models. LRA is a regression method which uses a set of continuous or binary independent variables which best forecast the probability of an event occurring, or not, or the value of a binary dependent variable (Norušis, 1993, p1-2). Variables in the two questionnaires are in both continuous and binary forms. As the chosen dependent variables for satisfaction perception and visitor density preferences studies were designed as binary categories (yes/no questions), LRA has been used in this study to predict the probability of visitors' recreation preferences occurrence.

3.3.2.1 LRA Method Selection and Data Preparation

In the procedure of logistic modelling, the *Forward LR* (*Forward* Stepwise *Selection*) method was used to control the entry of independent variables into the model. Removal testing is based on the probability of the likelihood-ratio statistics based on the maximum-likelihood estimates (Norušis, 1993). In LRA, *Forward LR* was functioned as Stepwise *Selection* method in Linear Regression. In order to select the best model, various combinations of available independent variables and contrast methods (*Deviation* and *Indicator* contrast methods for producing dummy-variables) were tested to predict the probability of visitor preference perception in terms of visitor satisfaction and visitor density preferences. More details are given in the LRA section in Chapter 5 (Section 5.4).

3.3.3 Factor Analysis

There are 53 and 77 variables in the 'satisfaction' and 'crowd density' questionnaires, respectively. Considering the large number of variables, an attempt was made to identify a few variables ('factors') which best represented the recreation issues (Figure 3.2). Factor Analysis was used to identify 'factors' that explain the correlation among a set of variables. A large number of variables are summarised by a smaller number of 'factors' (Norušis, 1993). 'Factor' variables were then used as independent variables within LR in place of the original data. The operation procedures are detailed in Chapter 5 (Section 5.5).

3.4 GIS Application in Recreation and Natural Resource Management

3.4.1 Overview of the Adopted IDRISI Modules

GIS was used to analyse the effect of recreation development alternatives under the considerations of conservation management. The IDRISI GIS software was utilised as a decision making support system in this study. The modules in IDRISI used for this approach included OVERLAY, VIEWSHED, COST, DISTANCE, BUFFER, PATHWAY, DATA IMPORT, MCE and WEIGHT (Distance Map studies with the aid of ARCVIEW software). The main function of each module is summarised in Appendix E.

3.4.2 Spatialisation of Bio-Physical Data

The mapping data in this study have been classified into two categories, physical data and recreation data. The former contains topography, soil, geology, waterways, roads, compartment boundaries and sub-compartment. The latter contains recreation resource data (including recreation facility and wildlife data) and recreation perception data (satisfaction and crowd density data) from the Park publications and questionnaire survey. The wildlife data (biological data) including the mapping of fauna and flora will be introduced in this section.

3.4.2.1 Data Preparation and Digitising

Topography, soil, geology, waterways, roads, compartment boundaries which were available in pre-digitised form from the Park (scale 1:20000) and sub-compartment boundaries were digitised from Chitou's paper maps by the author (scale 1:5000). The latter contain recreation resource data (including recreation facility and wildlife data). Recreation perception data (satisfaction and crowd density data) were available from the Park publications and questionnaire survey. The wildlife data (amount, distribution in the Park, and the importance) came from two sources; the Park publications (birds and frogs) and expert opinions (rare trees and butterflies). Visitors interest in wildlife was investigated by 'Satisfaction' and 'Crowd Intensity' Questionnaire surveys (Appendix A and B).

3.4.3 Spatialisation of Socio-Economic Data

3.4.3.1 Data Definition and Preparation

To investigate the Socio-Economic aspects of the Park, visitor recreation preference in terms of satisfaction (from 'Satisfaction Questionnaire') and remoteness (from 'Crowd Intensity Questionnaire') preferences were examined. In addition, the amenity and conservation value (WTP study) of the Park were included. Regression and Factor analyses methods were applied for the identification of the decisive variables. The third questionnaire, the 'Landscape Component Preference', was an attempt to identify the preferred landscape features of visitors, and was not included in the mapping (The analysis and quantification of variables were shown in Chapter 4).

Once the decisive variables of the Socio-Economic data were identified, they were mapped as Element Maps (Satisfaction Map and Distance Map), and were employed for the study of development of new paths and viewpoints.

3.4.4 Creation of Element Maps

Factors or elements, including visitor satisfaction, availability of resources, cost, visitor distribution and environmental impact have to be considered when managing natural resources. The mapping of the Elements to identify the most suitable areas in the Park for recreation development lead to the creation of 'Satisfaction', 'Recreation Resource', 'Cost', 'Distance' and 'Environmental Impact' (Steep Slope and Conservation) Maps. The creation methods are overviewed below:

(I) Creation of Satisfaction Map

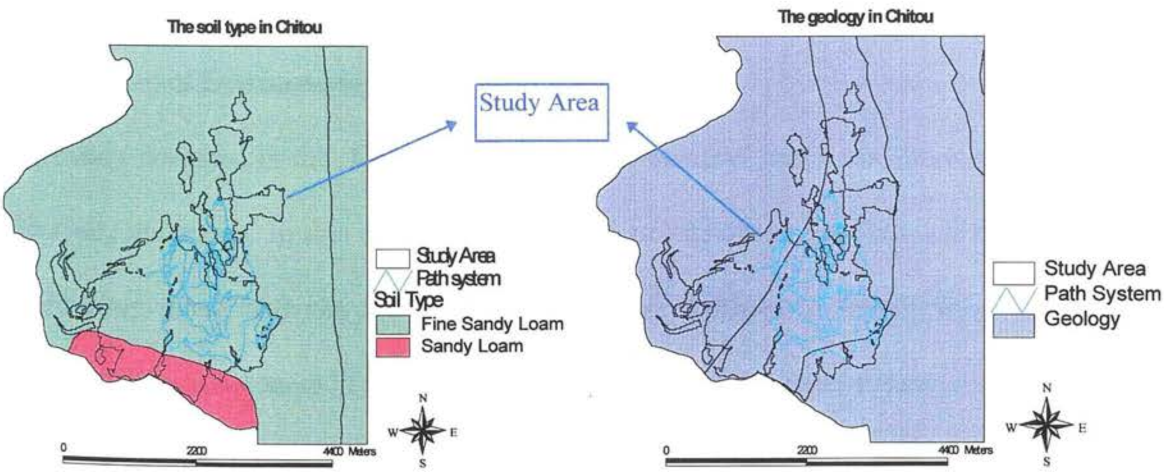
Using the Chitou Planting Database (Appendix F), the decisive variables of visitor satisfaction preference for enjoyment were first identified, then mapped to produce the 'Satisfaction Map'. Sub-element maps including tree species, tree age, planted areas, planted density and tree volumes were prepared by importing data from the Planting Database into IDRISI. The importing procedure is detailed in Chapter 6 (Section 6.1.4).

Due to the mountainous zone in which the Park is located, and the effect of this on landscape visibility, elevation variation was the next variable considered. DTM, tree height and the average eye height (defined as 1.5m) were three factors considered and subsequently combined with each of the sub-element maps. This 3-Dimensional procedure is completed by running the IDRISI VIEWSHED module. A programme VISTA was written (Appendix G) to help the repetition of the VIEWSHED module. The detailed creation procedure of the 'Satisfaction Map' is described in Chapter 6 (Section 6.3.2).

(II) Creation of Cost Map

Cost is another decisive factor which must be considered when examining recreation development. The cost of building a new path leading to new viewpoints includes variables such as slopes, soil types, geology, river crossings, logging cost (related to tree density) and remoteness.

Based on the map scale 1:20000, the majority of the Study Site is covered with a fine sandy loam (Figure 3.4a), consequently the soil type of the Study Area was considered to be homogeneous. The sandstone structure of Chitou is similar throughout the area (Figure 3.4b), as a result, both the soil and geology factors were excluded in this cost study.



(a) The soil types in Chitou (b) The geology in Chitou

Figure 3.4 The soil types and geology are quite simple and defined as largely homogeneous in map scale 1:20000.

As this study is concerned with developing a methodological approach which focuses on the application of visitor recreation preferences on park planning and management, the building cost factors were simplified. The primary factor in constructing a path network cost map was considered to be elevation (calculated from the DTM). As Agatec (1983) indicated, when the slopes are greater than 15 degrees, shallow steps are needed. Contour paths with steep steps are required when the slopes are greater than 25 degrees and should be avoided, and the National Park Law prohibits development on slopes greater than 30 degrees. The Cost Map was subsequently produced using slopes that were equal to or less than 25 degrees. The principle was adopted that the steeper the slope, the greater the building cost.

(III) Creation of Recreation Resource Map

Wildlife including birds, butterflies and ornamental trees were considered as recreation resources. The birds information came from the Park publications, the butterfly distribution and ornamental trees came from expert opinions. The distributions were mapped, separately and overlaid.

(IV) Creation of Distance Map

A question designed in the 'Crowd Intensity Questionnaire' asked visitors to write down the paths they had taken. In this way, the distribution of visitors in the Park was examined. This information, along with the aid of the path average distance to the entrance, was used to investigate the remoteness preference. A Distance Map was created based on the relationship between the visitation ratio and remoteness. The creation procedure is detailed in Chapter 7 (Section 7.5).

(V) Creation of Environmental Sensitivity Map

Certain environmental factors including high slopes, erodable soil, fragile geological texture and rare wildlife are sensitive to path building and were used to create as an impact index for the mountainous areas. Development in those areas where the above factors exist, should be avoided. The soil and geology of the area were not considered (see Section 3.4.4(II)). High slopes and rare wildlife were mapped, separately, producing two Environmental Sensitivity Maps. The detailed mappings procedures are presented in Chapter 7 (Section 7.6).

(i) The Steep Slope Map

The Study Areas with slopes greater than 25 degrees were extracted from the original Slope Map (scale 1:20000) using the RECLASSED module.

(ii) The Conservation Map

Rare trees and frogs were defined as conservation wildlife species in the Park. The rare tree distribution was marked on the Current Path Map (scale 1:5000) by plant ecology experts in Chitou. The frog information came from Park publications. Both were mapped and combined to produce the Conservation Map.

3.4.5 New Viewpoints and Path Design and Selection

Element Maps including the Recreation Satisfaction Map, Recreation Resource Map, Cost Map, Distance Map and the Environmental Impact Map were considered as variables in the final selection of new viewpoints and pathways. An IDRISI module, using Multi-Criteria Evaluation (MCE), was adopted as a decision support tool. The four Element Maps except the Environmental Impact Map were defined as Factors, and the Environmental Impact Maps (the Steep Slope and the Rare Tree Maps) were defined as Constraints. As a Factor, the relative importance of each map criterion was considered. For example, is it more important to have lower road-building cost, than it is to have high visitor satisfaction? As a Constraint, the map has to be in a Boolean (1 or 0; yes/no) format. For example, do you avoid areas where slopes are greater than 25 degrees?

To investigate the development possibilities, three scenarios (Baseline, Satisfaction Priority and Cost Priority) were created based on the various priorities allocated to them. Constraints were then integrated using the MCE module to identify the most suitable development areas.

Both the Best Suitability Areas and High Satisfaction Areas were identified and used for the selection of the 6 top ranking viewpoints. A new path was then designed which connected the viewpoints via the highest quality areas. A least ranked route, (i.e. the most suitable areas which were re-assigned with the lowest pixel scores to meet the special need while PATHWAY module was running), was created using COST and PATHWAY module (Figure 3.5). The detailed procedure is described in Chapter 7 (Section 7.8).

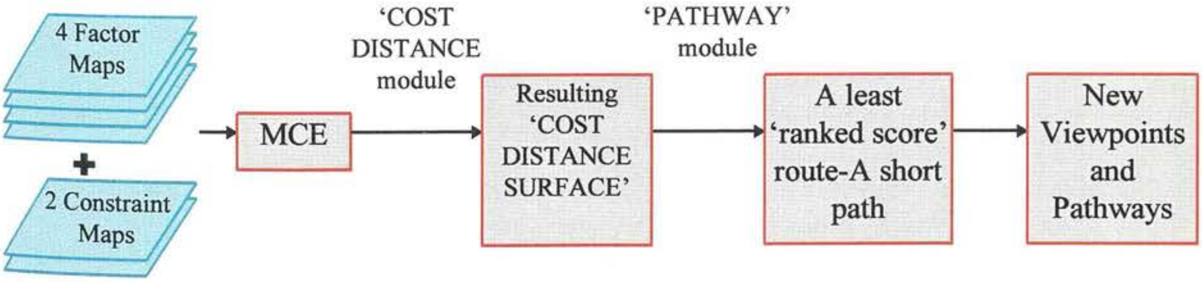


Figure 3.5 A summary of the approach procedure involved in viewpoint selection and route planning .

Each resulting pathway obtained from each of the three alternative scenarios (based on 3 different priorities of the Factors) were compared and the best one was chosen.

CHAPTER 4. PRIMARY RESULTS

4.1 Introduction

To achieve the management objectives of high recreation enjoyment, proper natural resource management and forest amenity improvement, questionnaire surveys were under taken.

This chapter will explain how visitor recreation preferences (satisfaction and crowding) and landscape preferences (for recreation planning and management) were quantified. The primary results of a questionnaire survey focus on visitor preferences for viewpoints, plantations, landscape components, colour, recreation facilities and information demands. In addition, crowd perception, visitor distribution, path planning, and visitor willingness to pay, results are described herein.

Three questionnaires examining Satisfaction[(i)] , Crowd Intensity Perception[(ii)] and Landscape Preferences[(iii)] to visitors in Chitou were designed. Interviews were undertaken with 226, 214 and 216 visitors, respectively during visitor peak time in July and August, 1995. Statistical analyses including Frequency, Percentage, Chi-Square Test, Nonparametric Chi-Square Test, Kolmogorov-Smirnov Test, Crosstab and Multiple Response Frequency Tables or Crosstabulation were applied to the data.

(i) Questionnaire to assess visitor satisfaction with recreational facilities of Chitou (Appendix A)
(ii) Questionnaire to assess visitor reaction to crowd experience of Chitou (Appendix B)
(iii) Questionnaire to assess visitor reaction to landscape components in Chitou (Appendix C)

4.2 Primary Result of Satisfaction Study (Questionnaire A)

4.2.1 Park Preference and Decision Factors

4.2.1.1 Factors affecting distribution of visitors

Visitor demand and the attractive features of recreation areas have to be considered while planning to improve the management of forest parks or national parks. As Figure 4.1 showed the most important factors affecting visitors' decision on which park to visit was the *amenity of the landscape*, *low visitor density* and *the condition of paths* in the park. *Entrance fee* was the least important factor affecting visitor decision. Preference between the 7 attracting factors was significantly different ($\chi^2 = 362.4711$, DF= 6, $P < .0001^{**}$) (Figure 4.1).

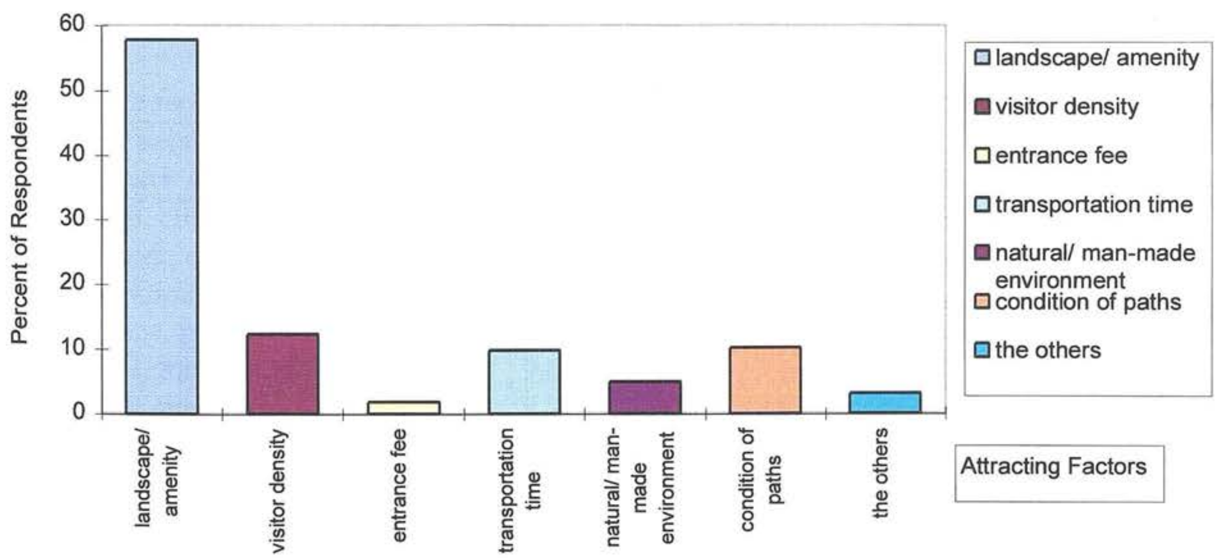


Figure 4.1 The general factors affecting where visitors will go.

4.2.1.2 Park Preference

Assuming that of the 5 parks in Taiwan (Chitou, Yan-Ming Mountain, Wulie, Shan-Lin-Shea and Kending), all had the same travel distance and had the same entrance fee. Interviewees were asked to choose their most favoured parks among them. Excluding Kending, which has viewpoints towards both mountains and the sea, Chitou was the most popular park (Table 4.1).

Table 4.1 The order of attractiveness of the 5 parks in Taiwan.

Parks	Features	Percent of Visitors	Order of Park Preference
Chitou Forest Recreation	mountainous	30.5	2
Yan-Ming Mountain National park	mountainous	16.6	3
Wulie Recreation Area	mountainous	4	5
Shan-Lin-Shea Recreation Area	mountainous	8.5	4
Kending National Park	mountainous & sea	40.4	1

When respondents were asked what factors were the most important when deciding which park to visit, results showed that landscape and viewpoints were the most important (Table 4.2).

Table 4.2 The factors affecting visitors' decision on which park (Table 4.1) to visit

Affecting Factors to Visitors on park chosen	Percent of Visitors
1. air, cool, climate	11.5
2. visit times, experiences	12.1
3. sea, swimming	8.6
4. landscape, points	23.0
5. distance, transportation	9.8
6. amenity, preference	9.2
7. planning	2.3
8. interesting	4.0
9. quiet	1.7
10. changeable, diversity	2.3
11. nature, conservation	6.9
12. the others	8.6
Total	100

4.2.2 Viewpoints

Visitors were attracted to Chitou for 3 main reasons; views of landscape, avoidance of hot weather and the opportunity to see both natural and man-made forests (Table 4.3). Visitors questioned after their visit (Table 4.4) favoured the cool and quiet environment, although attractive landscapes and the viewpoint factor was still among the top most impressive characteristics (23.7%). From 13 alternatives, *University Pond* viewpoint was the most favoured (Table 4.5), and the least favoured was *Deer Garden*.

Table 4.3 The reason attracting visitors to Chitou

ATTRACTING REASON	Attractive Reasons Before Visiting % of Visitors
1. landscape/points	22.4
2. wildlife interest /conservation	11.6
3. forest environment	16.5
4. the fame of a resort/ popularity	7.5
5. research purpose	2.4
6. group tour activities	7.9
7. avoid hot weather	17.3
8. recreation facilities	5.2
9. transportation	5.2
10. cheap entrance fee	1.4
11. no special reason	1.9
12. others	0.5

Table 4.4 The characters of Chitou which visitors liked the most after visiting

IMPRESSED REASON	Preference After Visiting % of Visitors
1. landscape/viewpoints	23.7
2. path design/ landscape along paths	13.1
3. wildlife interest/ conservation	28.5
4. cool temperature and quiet environment	29.2
5. research purpose	1.7
6. recreation facilities	2.5
7. others	1.4

Table 4.5 The most favourite viewpoint in Chitou

Viewpoints	Percent of Visitors	Viewpoints	Percent of Visitors
1. Red mansion	2.5	9. Natural forest	14.4
2. Campsites	1.3	10. The great spiritual tree	15.2
3. Picnic Area	1.3	11. The observation tower	4.2
4. Bamboo living collection garden	5.2	12. Moso Bamboo & Bamboo house	13.7
5. Nursery	4	13. University Pond	19.8
6. Deer garden	0.7	16. the others _____	2.6
7. Ginkgo forest	11.3		
8. Man-made forest	3.9		

In general, visitors thought that there were sufficient viewpoints in Chitou (Figure 4.2) (χ^2 = 9.8178, DF= 1, P < .01). However, Table 4.6 shows clearly that more viewpoints would be welcome (χ^2 = 104.2870, DF= 10, P < .0001).

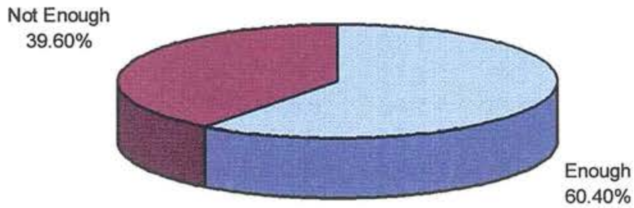


Figure 4.2 Visitors' opinions of the amount of viewpoints. (χ^2 = 9.8178, DF=1, P = .0017)

Table 4.6 The expected new facilities in Chitou

FACILITIES	*viewpoint*	*footpath*	*shelter*	*play yard*	*campsite*	*chair*
Percentage of visitors who expected new facilities	23.3	8.5	16.6	6.7	1.8	8.1
FACILITIES	*route map*	*signpost*	*tour guide*	*others*	*enough facilities*	*Total*
Percentage of visitors who expected new facilities	7.6	3.1	13.0	1.8	9.4	100

(χ^2 = 104.2870, DF=10, P < .0001)

4.2.3 Plantation Preferences

When visitors were asked to score the six kinds of forest plantation types (man-made conifer, man-made broad-leaved trees, man-made mixed forest, bamboo forest, natural forest and forest rest lawn) into 6 levels (0, 1-5, from dislike, through like to strongly like) (Table 4.7), bamboo and natural forest were preferred over the other types ($P < .01$) (Table 4.8) (Figure 4.3). The statistical comparison was made using the Kolmogorov-Smirnov 2-sample Test (K-S test). The K-S test works to compare the cumulative distributions of a variable between two non-related groups and the maximum positive, negative and absolute differences. The K-S Z figure is then computed along with the two-tailed probability level (Norušis, 1993, p400).

Table 4.7 The preference extent from dislike(0) to strongly like(5) to the different types of forests.

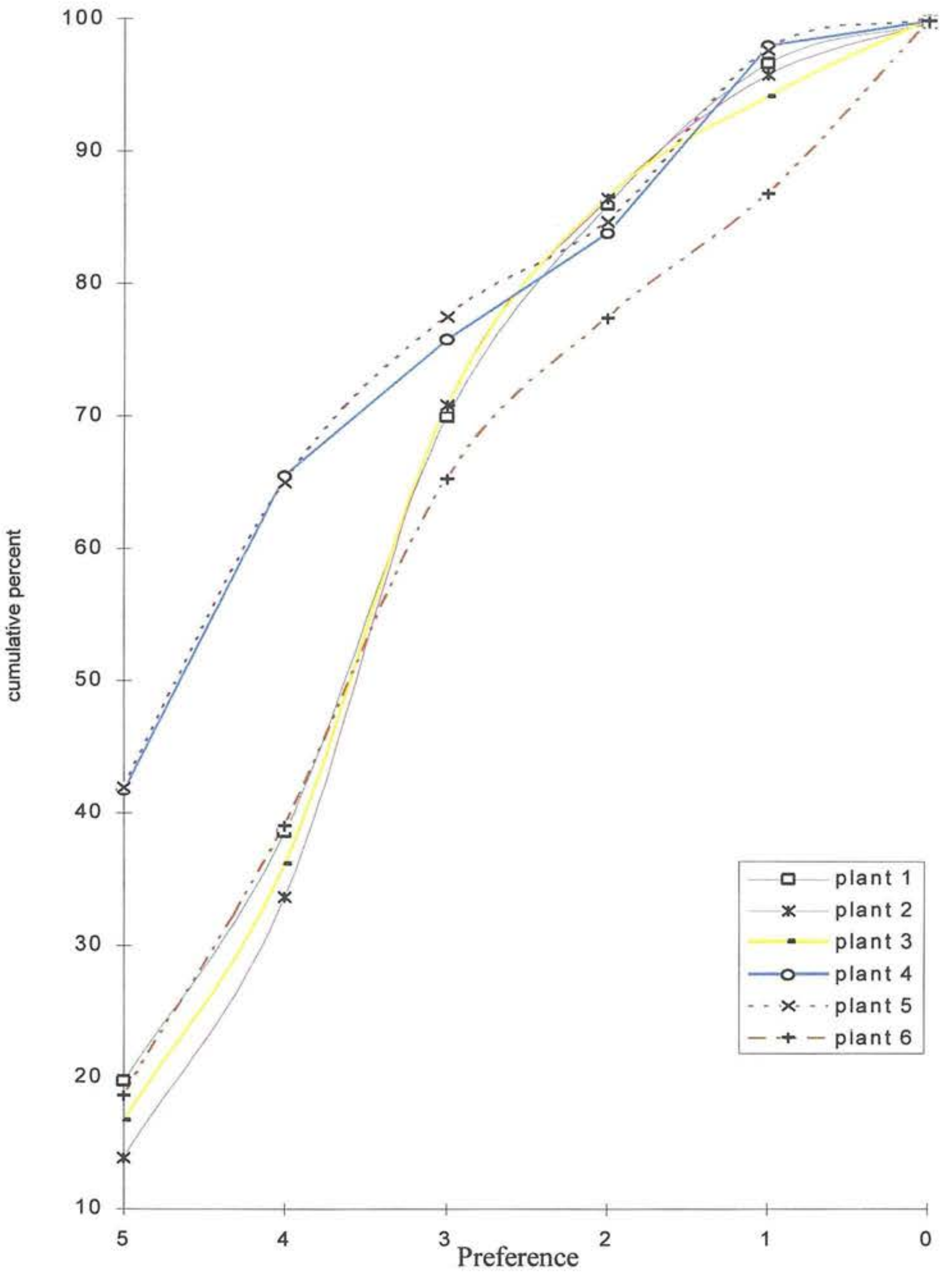
Six Levels of Preference	**Dislike->**	**Like ----->**	**------------->**		**Strongly Like**		
	0	**1**	**2**	**3**	**4**	**5**	**Total**
Forest Types							
Man-made Conifers	3.1	10.8	16.1	31.4	18.8	19.7	100%
Man-made Broad-leaved	4.0	9.4	15.7	37.2	19.7	13.9	100%
Man-made Mixed Forest	5.9	7.7	15.8	34.7	19.4	16.7	100%
Bamboo Forest	1.8	14.3	8.1	10.3	23.8	41.7	100%
Natural Forest	2.3	13.1	7.2	12.6	23	41.9	100%
Forest Rest Lawn	13.1	9.5	12.2	26.2	20.4	18.6	100%

Table 4.8 The differences of preferences within each two forests using K-S test.

Forest Comparison Pairs	**Forest1&2**	**Forest1&3**	**Forest1&4**	**Forest1&5**	**Forest1&6**	**Forest2&3**	**Forest2&4**	**Forest2&5**
Absolute Differences	0.0583	0.03064	0.26906	0.263	0.09983	0.03275	0.33003	0.31983
2-Tailed P(Significant P)	0.843	1	0	0	0.219	1	0	0
Significance	NP	NP	P*	P*	NP	NP	P*	P*
Forest Comparison Pairs	**Forest2&6**	**Forest3&4**	**Forest3&5**	**Forest3&6**	**Forest4&5**	**Forest4&6**	**Forest5&6**	
Absolute Differences	0.0904	0.29	0.28829	0.09111	0.01693	0.26657	0.25743	
2-Tailed P(Significant P)	0.806	0	0	0.317	1	0.002	0.002	
Significance	NP	P	P*	NP	NP	P*	P*	

(P*: extremely significant differences, $P < .01$; NP: not significant differences , $P > .05$)

key: Forest 1: man-made conifer
Forest 2: man-made broad-leaved trees
Forest 3: man-made mixed forest
Forest 4: bamboo forest
Forest 5: nature forest
Forest 6: forest rest lawn
Forest1&2: The difference of preferences between Forest 1 and Forest 2 (Forest1&3: ....)



key: Plant 1: man-made conifer
Plant 2: man-made broad-leaved trees
Plant 3: man-made mixed forest
Plant 4: bamboo forest
Plant 5: nature forest
Plant 6: forest rest lawn

Figure 4.3 The cumulative percentages for the preferences to the six types of forest plantations

For plantation composition, visitors liked both pure and mixed forest types rather than others very much (both P< 0.0001) (Table 4.9). There were no significant differences of preference in between pure and mixed forest types (Figure 4.4) (χ^2 = 7.24713, DF=10, P = .70193 > 0.05).

Table 4.9 Nonparametric Chi-Square Test for the preferences to the forest composition and landscape diversity.

Landscape Category	χ^2	**D.F.**	**P**
pure forest	138.6549	10	<.0001
mix forest	233.9557	10	<.0001
landscape diversity 1 (simple)	282.6000	9	<.0001
landscape diversity 2 (less simple)	246.9204	9	<.0001
landscape diversity 3 (less complex)	102.8319	10	<.0001
landscape diversity 4 (complex)	105.2655	10	<.0001
path-like	159.0359	5	<.0001
path-dislike	131.1962	5	<.0001

(D.F.: Degree of Freedom)

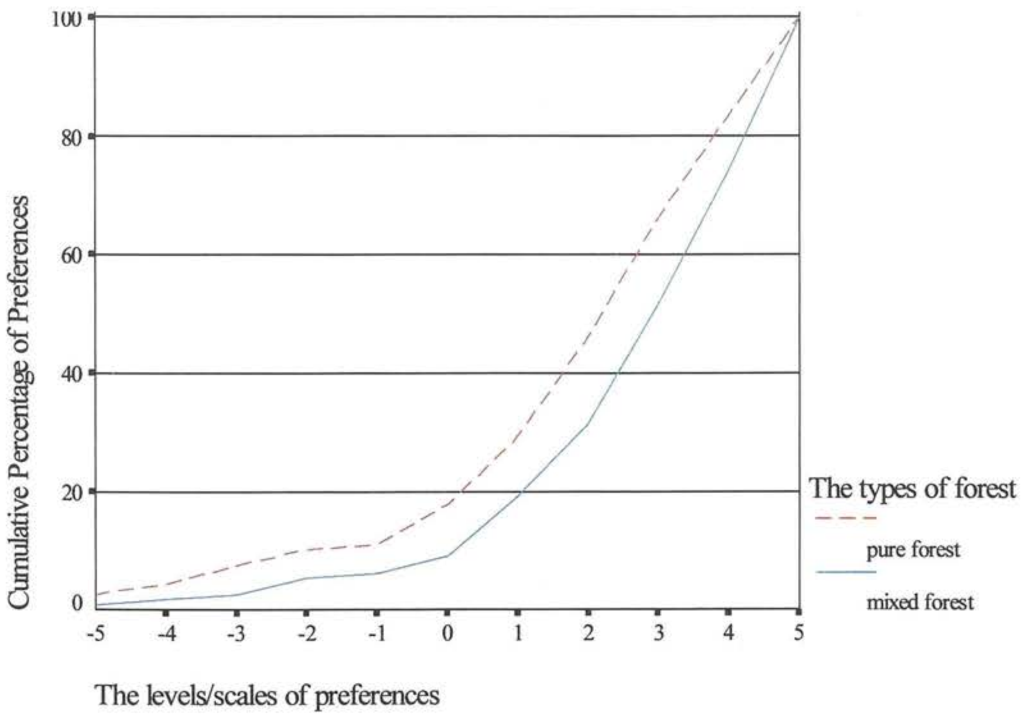


Figure 4.4 The preferences to forest plantation composition.

4.2.4 Landscape Preferences

4.2.4.1. Landscape Complexity *(from simple, landscape diversity photo 1, to complex, photo 4)*

Landscape arrangement and structure were studied to find what aspects visitors specifically liked to visit in forest parks and to encounter along paths. Photographs representing varying levels of landscape complexity from simple, to complex were showed to visitors in the parks. The preferences for landscape complexity were discriminated into 11 levels (-5 to +5). While visitors liked all four kinds of landscape shown to them, they significantly preferred simple landscape arrangements (i.e. Landscape Diversity photo 1 & 2 rather than Landscape Diversity photo 3 & 4) (Table 4.10).

Table 4.10 Preferences to the landscape complexity using K-S Test.

Comparison Pairs	Div. 1&2	Div. 1&3	Div. 1&4	Div. 2&3	Div. 2&4	Div. 3&4
Absolute Differences(χ^2)	.06941	.42914	.25454	.38175	.24462	.16902
2-Tailed P (Significant P)	.970	<.0001**	.003**	<.0001**	.005**	.117

(**: P< 0.01 ; *: P< 0.05)

where Div. - Landscape Diversity
Diversity 1 - simple; Diversity 2 - less simple;
Diversity 3 - less complex Diversity 4 - complex

4.2.4.2 Plantation Arrangement Along Paths

For the plantation arrangement along paths, six levels of plantation arrangement from simple to complex were shown in photographs to interviewees. Results showed a significant difference in visitor preference (χ^2 = 159.0359, DF= 5 & P < .0001**). The most favoured landscape arrangement was the simplest arrangement (photograph

No. 1) and the least favoured, was the photograph with a complicated arrangement with plantations randomly arranged along roads (photo 4 or 5). This result showed that the visitors to Chitou preferred simple and regular landscape arrangement.

4.2.5 Colour Preference

The majority of visitors to Chitou (83.9%) preferred the landscape with seasonal colour changes (χ^2 = 102.2466, DF=1, P < .0001**). The colours of light green and dark green were strongly preferred (P< .0001**), while the colours red, yellow, orange and brown in landscape composition were also preferred (P< .0001**) (Table 4.11 and 4.12).

Table 4.11 The preference for the proportion of each colour in scenery

Colour Proportion	**Red**	**Light Green**	**Dark Green**	**Yellow**	**Orange**	**Brown**	**Bright**
0-20%	47.3	8.6	7.2	45.9	48.6	43.7	5.5
21-40%	16.2	13.6	10.3	14.9	16.2	17.1	7.0
41-60%	19.8	24.0	22.0	21.2	20.7	23.4	22.6
61-80%	11.3	30.3	30.5	13.5	10.8	11.7	39.2
81-100%	5.4	23.5	30.0	4.5	3.6	4.1	25.6
χ^2	116.4234	33.8190	52.7623	109.1261	131.9639	100.3874	78.0603
DF	4	4	4	4	4	4	4
P	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

Table 4.12 K-S Test for the preference to six colours in landscape composition.

Comparison Pairs	Red & Dgreen	Red & Lgreen	Red & Yellow	Red & Orange	Red & Brown	Dgreen & Lgreen	Dgreen & Yellow
Absolute Differences	.45745	.41533	.02636	.02149	.03515	.07303	.43224
2-tailed P (Significant P)	<.0001	<.001	1.000	1.000	1.000	.953	<.0001
Dgreen & Orange	Dgreen & Brown	Lgreen & Yellow	Lgreen & Orange	Lgreen & brown	Yellow & Orange	Yellow & Brown	Orange & Brown
.47000	.44694	.38396	.43000	.37465	.05261	.03030	.05261
<.001	<.001	<.001	<.001	<.001	.999	1.000	.999

Where Dgreen: Dark Green; Lgreen: Light Green (**: extremely significant, P< .001)

The Cumulative Percentage of Preference results showed that people liked red, orange and brown in small amounts but preferred light green and dark green in large amounts (Figure 4.5, Table 4.11). The study found a preference in the extent of brightness in the forest environment (i.e. canopy or stand density). Visitors preferred a high level of brightness ($\chi^2 = 78.0603$, DF= 4, P < .0001**) (Table 4.11).

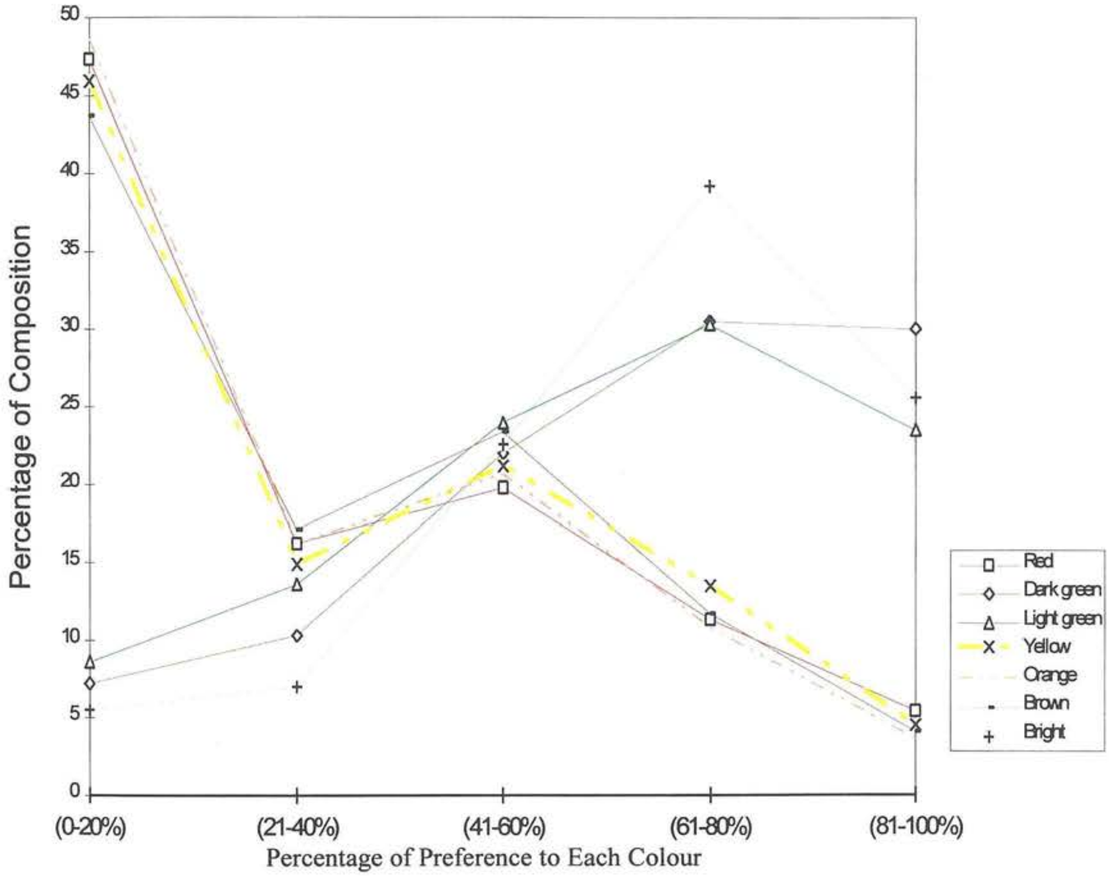


Figure 4.5 The preferences for each colour in landscape composition

4.2.6 Recreation Facilities

Satisfaction with recreation facilities including social (toilets, bins, etc.) and natural (paths, viewpoints, bridges, etc.) facilities were examined. Just under half of the visitors (46.4%) to Chitou were not satisfied with the facilities, two popular reasons given were that they were 'not extensive enough' and that they were in 'poor maintenance' (Figure 4.6).

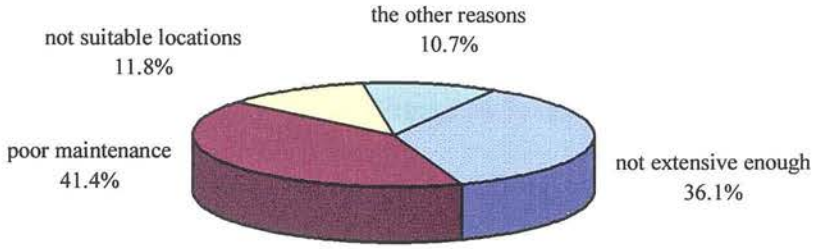


Figure 4.6 Reasons why visitors were dissatisfied with the facilities in Chitou. (data from 46.4% of unsatisfied visitors)

In particular, visitors were dissatisfied with toilets (53.8%), signposts (16.3%) and shop facilities (12.5%) (Table 4.13). However, first choice, in response to improved facilities questioning was the increase in the number of viewpoints (23.3%) (refer to Table 4.6). The second choice was for more footpaths/ route maps (16.1%). More viewpoints and paths and a clear route guide would be appreciated by the majority of visitors.

Table 4.13 Dissatisfaction with particular facilities

Dissatisfied Facilities	*Percent of Visitors*
toilet	53.8
shops	12.5
general facilities	1.0
signpost	16.3
restaurant	1.0
rubbish	7.7
hotel	5.8
footpaths	1.0
shelters	1.0
Total	100

4.2.7 Willingness to Pay

The majority of the visitors to the Park were older than 18 years old, and therefore most (59.6%) paid the general ticket equivalent of £2.50 for entrance fee (Table 4.14). Most of the visitors (62.8%) felt that this was a reasonable fee (Figure 4.7), although the result of Chi-Square Test (Figure 4.7) indicates that there were significant differences among visitors' opinions (P< 0.001).

Table 4.14 The Entrance fee which visitors had paid.

Entrance Fee*	Ticket Classes	Percent of Visitors
£0.75	Childrens Ticket	1.3
£1.5	Student Ticket	26.2
£2	Group Ticket	12.9
£2.5	General Ticket	59.6

(* based on the exchange rate Sterling to New Taiwanese Dollars 1:40 in the summer of 1995)

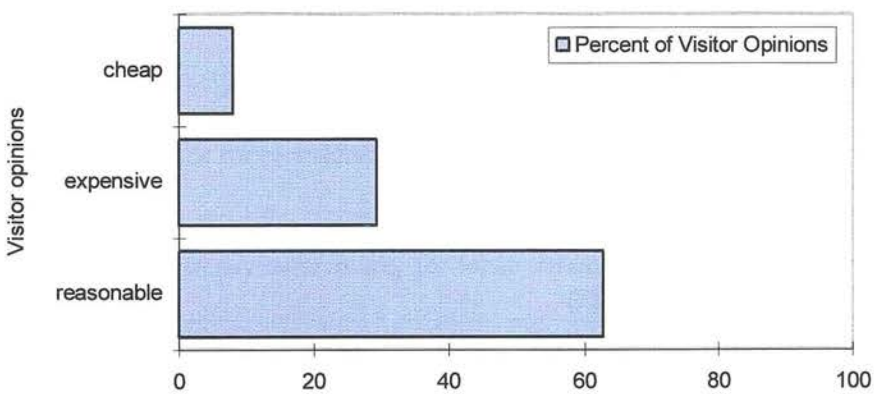


Figure 4.7 The opinions of visitors about the entrance fee
(χ^2 = 103.7876, DF=2, P < .0001**).

To investigate the value of landscape amenity in the Park, a WTP technique was adopted to evaluate the non-market value. Five options of extra entrance fee were presented to the respondents. Using a Nonparametric Chi-Square Test (NPAR Test), a significant number of visitors (79.6%) would be willing to pay a higher entrance fee ($P< .001$), if there were more or better viewpoints. Of these, 29.9 percent indicated that they would pay additionally more than the equivalent of £0.50 (Table 4.15).

Table 4.15 Willingness to pay extra money for more/ better viewpoints using NPAR Test.

(Sterling: NT$ = 1: 40)

Extra Fee For more/ better Viewpoints	**Percent of Visitors**
£< 0.125	14.4
£0.125-0.25	18.4
£0.25-0.375	10.3
£0.375-0.5	27.0
> £0.5	29.9
Total	100

(χ^2 = 23.8736, DF=4, P=.001** < .01)

The other WTP question in this questionnaire ('Satisfaction Questionnaire') evaluates the conservation value of Chitou to visitors. The same 5 options of extra entrance fee were given. The majority of visitors (67.8%) indicated that they would additionally pay more than £0.50 for more extensive conservation activity (Table 4.16).

Table 4.16 Willingness to pay extra money for conservation reasons using NPAR Test.

(Sterling: NT$ = 1: 40)

Extra Fee for Conservation	Percent of Visitors
£< 0.125	8.4
£0.125-0.25	9.9
£0.25-0.375	6.4
£0.375-0.5	7.4
> £0.5	67.8
Total	100

(χ^2 = 289.3861, DF= 4, P < 0.001)

4.2.8 Information Preference

Sixty percent of visitors did not think that sufficient information on the Park and its viewpoints was provided. There was a very significant difference between positive and negative opinions (χ^2 = 9.0000, DF=1, P = .0027**). Those who gave a negative response were asked what kind of information they required. Information on wildlife, ecology and conservation would have been preferred by 25.4 percent of visitors while 21.2 percent expected free introductory pamphlets (Table 4.17) (χ^2 = 81.8305, DF = 9, P< 0.0001**). The results of the Chi-Square Test showed that there were extremely significant differences among the information preferences of visitors (P< 0.001).

Table 4.17 The information preferences of visitors

Information Demanded	Percent of Chosen By Visitors
1. no need	16.9
2. tour guide, activities	10.2
3. viewpoints, recreation characters / facilities	12.7
4. pamphlet, introduction	21.2
5. wildlife, ecology, conservation	25.4
6. eating, living	4.2
7. maps	4.2
8. signposts	2.5
9. time tables	1.7
10.the others	.8
Total	100

(χ^2 = 81.8305, DF = 9, P< 0.0001**).

4.2.9 Other Preferences

4.2.9.1 Visiting Frequency

Most of the visitors (79.1%) responded that they would visit the Park again in the future (Figure 4.8), but when queried when, they were inexact (free time).

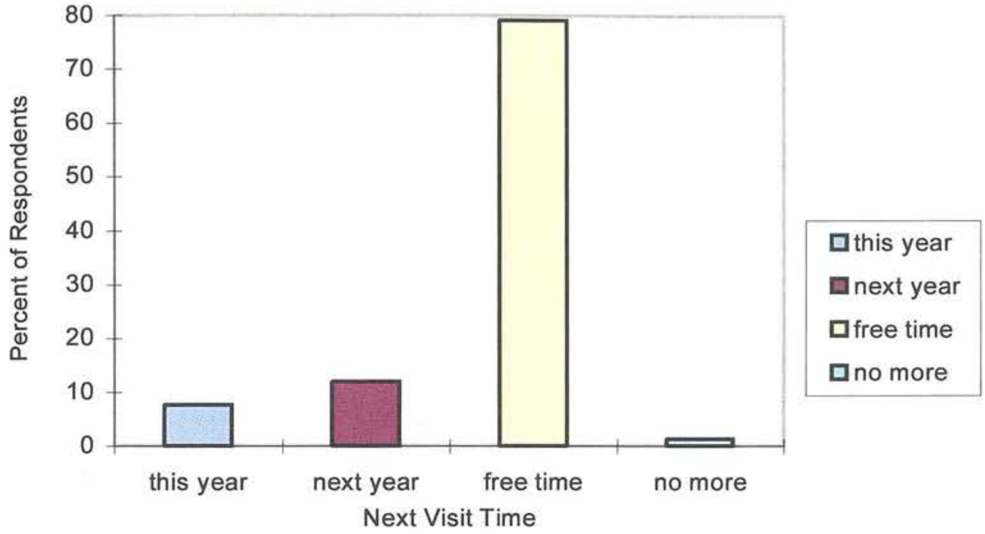


Figure 4.8 Time period within which visitors thought they would make their next visit to Chitou. ($\chi^2 = 356.5289$, DF=3, P < 0.0001**)

4.2.9.2 Travel Time

82.1 percent of visitors indicated that they would spend less than 5-6 hours travelling to the Park (Table 4.18).

Table 4.18 Maximum transportation time which visitors would be considered to spend on travelling to Chitou for one way journey

Maximum Transportation Time	*Frequency of Cases*	*Percent of Visitors*
1-2 hrs	6	2.8
3-4 hrs	82	37.6
5-6 hrs	91	41.7
7-24 hrs	16	7.3
> 24 hrs	23	10.6

($\chi^2 = 144.9817$, DF=4, P < .0001**)

The survey showed that 76.2 percent of the visitors spent less than 5 hours travelling to Chitou (Table 4.19). This result matches the maximum transportation time of visitors shown in Table 4.18.

Table 4.19 The transportation time which visitors actually spent on travelling to Chitou for one way journey

Transportation Time	Percent of Visitors	Total
0-2.9 hrs	45.7	76.2%
3-4.9 hrs	30.5	
5-6 hrs	18.4	23.8%
6.1-24 hrs	5.4	

4.3 PRIMARY RESULTS OF VISITOR DENSITY STUDY

The 'Crowd Intensity' Questionnaire (Appendix B) examined visitor crowd density preference and visitor distribution in the Park.

4.3.1 Interview Places and Visitor Amount

The survey dealing with visitor density was undertaken during the summer of 1995, and included 214 visitors to the Park. The majority of interviews (200) took part in two of the most popular viewpoints in the Park: *the University Pond* and the *Spiritual Tree* (Table 4.5). The remaining visitors were interviewed in the *Gingko Forest* and the *Bamboo House*.

The number of visitors around each interviewing site was counted every hour, this was used to represent the visitor density recorded on the questionnaire at a particular site and time. The result showed that there was, on average, less than two hundred visitor numbers at any one place. This figure increased to around 350 during peak times (around lunch time) of each day (Figure 4.9).

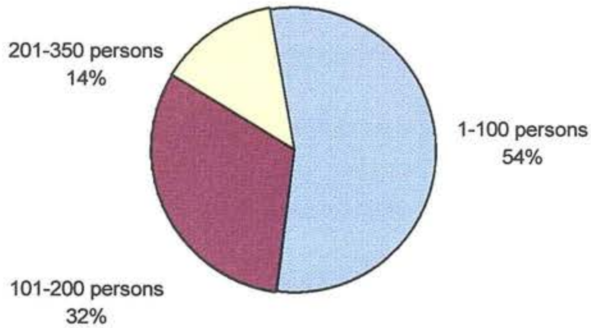


Figure 4.9 The percentage of interviews in each visitor density group

4.3.2 Crowd Perception

4.3.2.1 Crowd Experience

When visitors were questioned on crowd density, the positive and negative opinions of interviewees to people intensity was found to be almost evenly distributed (no significant difference, χ^2= .2991, DF=1, P = .5845) (Table 4.20).

Table 4.20. Pearson Chi-Square test for visitor perception of crowd density at peak time.

Crowd Experience	Count of Cases	Percentage of Visitors Felt Crowded
Yes	103	48.1
No	111	51.9

(χ^2 = .2991, DF=1, P = .5845)

Results showed that half of the visitors felt that crowd density was a problem in the Park. The difficulties of crowd density were obvious at some viewpoints (Figure 4.10).

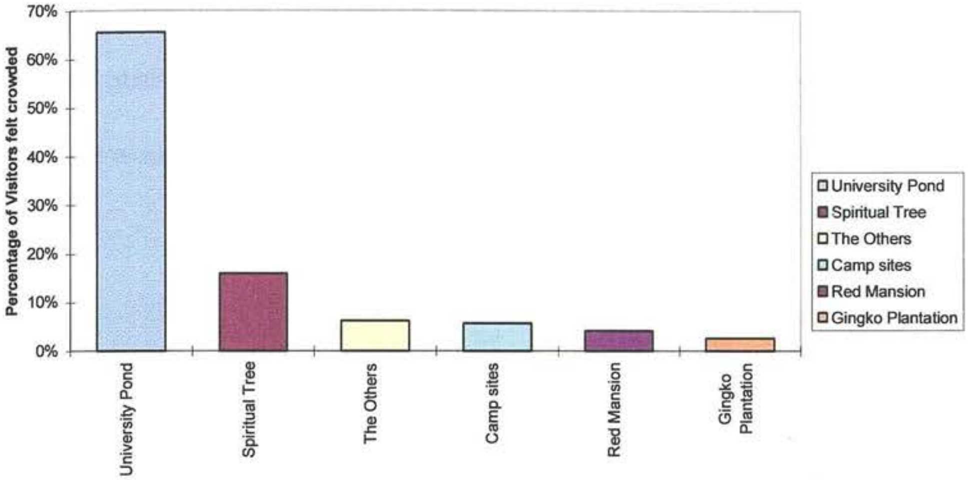


Figure 4.10 The crowd experience to the viewpoints in Chitou. ($\chi^2 = 345.5052$, DF=5, P < .0001**)

With respect to crowding at viewpoints, of the 214 interviewees, 194 (90.7%) said that they had experienced crowd pressure at some viewpoints. For these people, the majority experienced crowd pressure at University Pond (65.5%), Sixteen percent of visitors felt crowded at the Spiritual Tree (Figure 4.10).

When visitors were queried on crowd experience on paths, 59.4 percent of people would have preferred to meet less than 10 other persons along the paths. 202 of the visitors (94.4%) felt crowded while walking along footpaths (Figure 4.11).

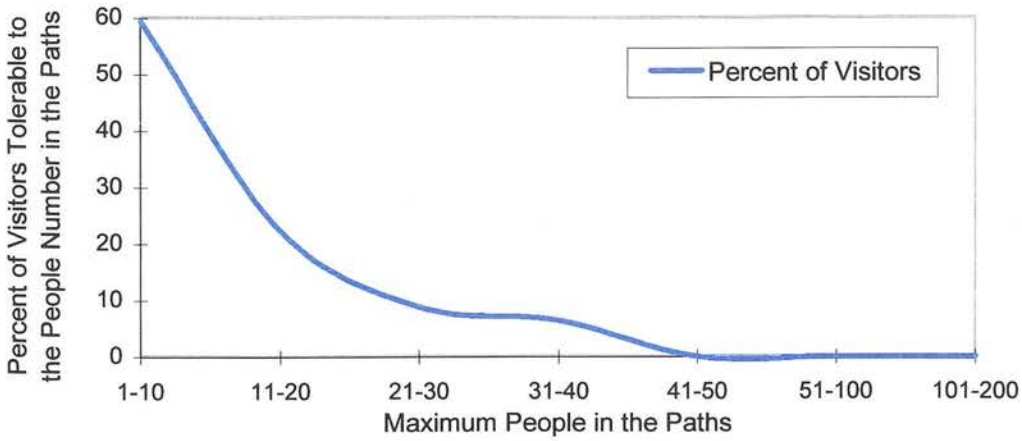


Figure 4.11 The amount of visitors which caused crowded feeling in the footpaths ($\chi^2 = 301.1089$, DF=5, P < .0001**)

Although visitors had different ideas about how to alleviate the feeling of crowd pressure, just under half of the interviewees (44.5%) thought that building more footpaths would improve the situation for them (Figure 4.12).

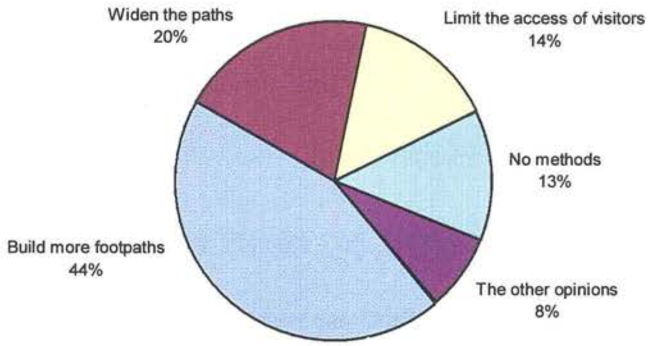


Figure 4.12 Visitors' opinions for the improvement of crowding
(χ^2 = 86.5263, DF=4, P < .0001**)

4.3.2.2 New Path Zone

To investigate the solution of a new path development to improve the crowd problem and distribute visitors in the Park more evenly, the current path network was mapped, numbers were assigned to each path and the network area was discriminated into 11 blocks for new paths study (Appendix H).

When visitors were interviewed where they would like to have a new path built to alleviate crowd pressure, 38.8 percent of visitors said that they would like to have a new path in BLOCK 7 (Appendix H); 22.4 percent of visitors would choose BLOCK 5 for a new pathway and 8.8 percent of visitors preferred BLOCK 6 (Table 4.21). The

NPAR analysis showed that there were very significant differences among visitor preferences for improvement ($\chi^2 = 212.2585$, DF=10 and P< .0001**).

Table 4.21 Visitors' preferences on the location (BLOCK) of new paths

BLOCK	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
Percent of Visitors (%) Like New Paths	0.7	3.4	6.1	5.4	22.4	8.8	38.8	3.4	2.0	5.4	3.4

(Chi-square = 212.2585, DF=10, P < 0.0001**)

Further analysis indicated that visitors (46.2%) would not give up a visit to Chitou even if the crowd extent were to increase while the entrance fee remained the same. Many felt that they could visit the Park avoiding peak season or peak times (see Table 4.27).

When questioned about the route selection through the Park, 41.6 percent of visitors considered viewpoint factors while choosing their visiting routes. 1.9 percent of visitors said that they had followed a crowd as an indication of where to go (Table 4.22) and 22.4 percent of visitors indicated that they had chosen their route by chance. This random selection suggests a lack of information to assist in route selection.

Table 4.22 Reasons of footpath route selection in parks.

REASONS OF ROUTE SELECTION	PERCENT OF VISITORS
1. the viewpoints which you were interested in visiting	41.6
2. chose them by chance	22.4
3. the landscape along footpaths	15.0
4. the distance of routes/ physical limitation	11.2
5. the limited time	6.5
6. follow a crowd	1.9
7. the other reasons	1.4

(χ^2 =180.0280, DF= 6, P< 0.0001**).

4.3.3 Path Type Preferences

Five colour pictures illustrating various Chitou footpaths constructed of different materials and types were presented to interviewees. The five road types represented were tar, slate surface, pebble, and earth surface road, and additionally, a staircase was considered. As a result, 30.5 percent of visitors preferred path designed as staircases and 26.3 percent chose a tar surface road. These two preferences were significantly higher than preferences for the other road types (Figure 4.13).

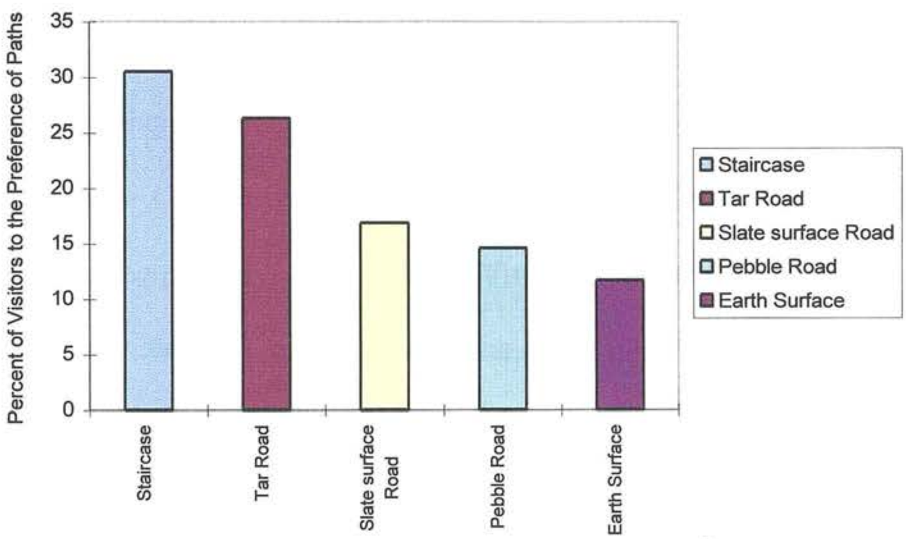


Figure 4.13 The preferences to the different footpath types (χ^2 = 27.4460, DF=4, P < 0.0001**)

Generally speaking, visitors were satisfied with the footpaths in the Park. Figure 4.14 illustrates a -5 to +5 point scale, the degree of satisfaction. The skew shows a mean of +2.6 indicating a positive view of the pathway system (Figure 4.14).

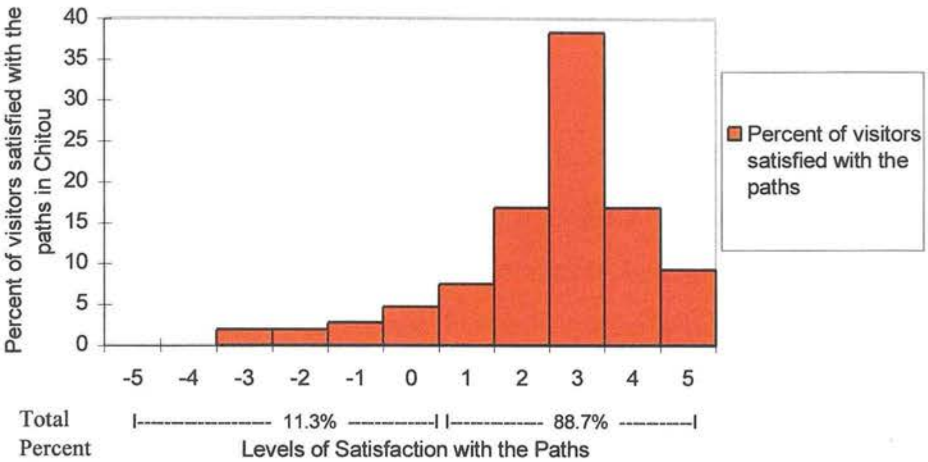


Figure 4.14 The satisfied extent with the footpaths in Chitou ($X^2 = 212.4486$, DF=8, $P < .0001$**)

When investigating the design of footpaths, results showed most visitors preferred wide footpaths (> 1 m); 41 percent preferred straight paths, and 50 percent indicated a liking for winding pathways (Figure 4.15). Visitors responses indicated that creating more and wider footpaths could improve the over crowding feeling (Figure 4.12). These factors should be considered during recreation planning. The Chi-square test showed that the visitor preferences to the four kinds of design of footpaths showed significant differences ($\chi^2 = 147.3585$, DF=3, $P < 0.0001$**).

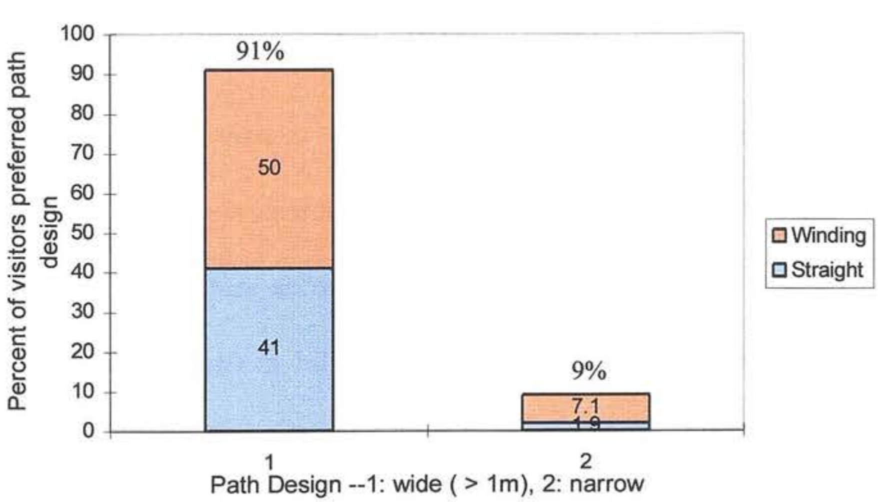


Figure 4.15 Visitors' preferences to the design of footpaths. ($\chi^2 = 147.3585$, DF=3, $P < .0001$**).

4.3.4 Path Route Selection and Preferences

4.3.4.1 Path Selection and Preference

In order to examine visitor distribution in the Park, two questions were included in the 'Crowd Intensity Questionnaire' to find out if visitors congregated in certain areas and caused over crowding. A question was also asked to look at which paths in the park are the most popular. The current footpath system was distinguished into 23 pathways and each path was assigned a number between 1 and 23. Visitor distribution among the path network is shown in Table 4.23. Pathways 1 and 2 were the most heavily used paths in the Park (refer to Footpath Network Map in Chitou (Appendix H)).

Table 4.23 Visited frequency of footpath routes in Chitou in July, 1995

Pathway	*P1*	*P2*	*P3*	*P4*	*P5*	*P6*	*P7*	*P8*	*P9*	*P10*	*P11*	*P12*
Percentage of Visitors' Visited Frequency of Pathways	68.5	64.8	39.0	31.5	40.8	39.4	21.1	20.7	17.4	32.4	42.7	31.9
Pathway	*P13*	*P14*	*P15*	*P16*	*P17*	*P18*	*P19*	*P20*	*P21*	*P22*	*P23*	
Percentage of Visitors' Visited Frequency of Pathways	30.5	27.7	20.2	19.2	17.4	17.4	11.7	21.6	22.1	18.3	23.5	

Pathway 1 is connected to the main entrance and is in essence, a 'feeder' route, although some of the visitors stayed in a Youth Hostel Centre (which can accommodate up to 418 persons/day) and started their walks from this point (refer to Figure 4.12). These visitors accounted for 12 percent of the average daily visitor amount (3348 persons/day) in July and August, 1995. The most heavily used route was considered to be pathway 2 because it leads to *the University Pond* - the most popular viewpoint in the Park.

To explore the popular pathways, visitors were questioned on their favoured pathways after visiting, results showed that pathway 2 was the most favoured (Table 4.24). The other popular pathways included 1,3,10,11,13 and 23. The result of NPAR Chi-Square analyses showed that the visitor preference to the pathways in Chitou had extremely significant differences (P < .0001**). This means some pathways didn't meet visitors' satisfaction and still had room for improvement.

Table 4.24 The favourite pathways in Chitou after visiting

Favourite Pathway	***P1***	***P2***	***P3***	***P4***	***P5***	***P6***	***P7***	***P8***	***P9***	***P10***	***P11***	***P12***
Percent of Visitors (%) Chose the Path	7.8	29.4	5.4	3.4	1.0	3.9	2.0	1.0	0.5	10.8	5.4	2.0
Favourite Pathway	***P13***	***P14***	***P15***	***P16***	***P17***	***P18***	***P19***	***P20***	***P21***	***P22***	***P23***	
Percent of Visitors (%) Chose the Path	6.9	2.5	1.0	0	0.5	0.5	1.5	2.9	2.0	0	9.8	

(χ^2 = 354.3529, DF=20, P < .0001**).

The reasons why the visitors chose certain pathways were:

1. that they led to viewpoints which were interesting (41.6%);

2. by chance (22.4%);

3. visitors liked the landscape along footpaths (15%);

4. the end point was not too far away (i.e. less demanding physically) (11.2%);

5. time allowance (6.5%);

6. the crowd led them along (1.9%)

7. other reasons (1.4%).

The main reason affecting decisions on which way to go was viewpoint attraction and this can be identified in the previous result of the most popular pathway (pathway number 2, Table 4.24), and the result of the most popular viewpoint (the University Pond, Figure 4.10) which is at the end of the pathway 2.

4.3.4.2 Favoured Features along Paths

To examine the favoured features which visitors liked to meet, a list of landscape elements and recreation resources were given to interviewees. Thirty percent of visitors indicated that they enjoyed 'natural woodland' the most while walking along the pathways. The result in Table 4.25 shows that along their route, visitors preferred natural objects of interest (e.g. "water/pond/bridge" and "wildlife") rather than "rubbish", "noisy people" and "car driving".

Table 4.25 The features which visitors like/dislike to meet along walks

Features Like/ Dislike to Meet		**Percent of Visitors (%)**
Like To Meet	nature forest	30.0
	man-made forest	3.6
	water/pond/bridge	20.6
	lawn/space in forest	8.1
	ornament plants/flowers	4.6
	recreation facilities	5.3
	buildings	1.0
	wildlife	19.6
	visitors	1.2
	art works, i.e. sculpture	5.0
	the others	1.0
Dislike To Meet	man-made forest	2.5
	buildings	8.1
	noisy people	20.6
	car driving	20.6
	snakes	8.2
	rubbish	30.3
	bare ground	9.5
	the others	0.3

4.3.4.3 Favoured Activities along Walks

In addition to favoured features, visitors' preferred activities while walking along paths were also considered. The result of a question relating to visitor activity while walking showed that viewing the landscape (31.5%) was the clear favourite (Figure 4.16). As indicated in Figure 4.16, observing wildlife was the next most popular activity.

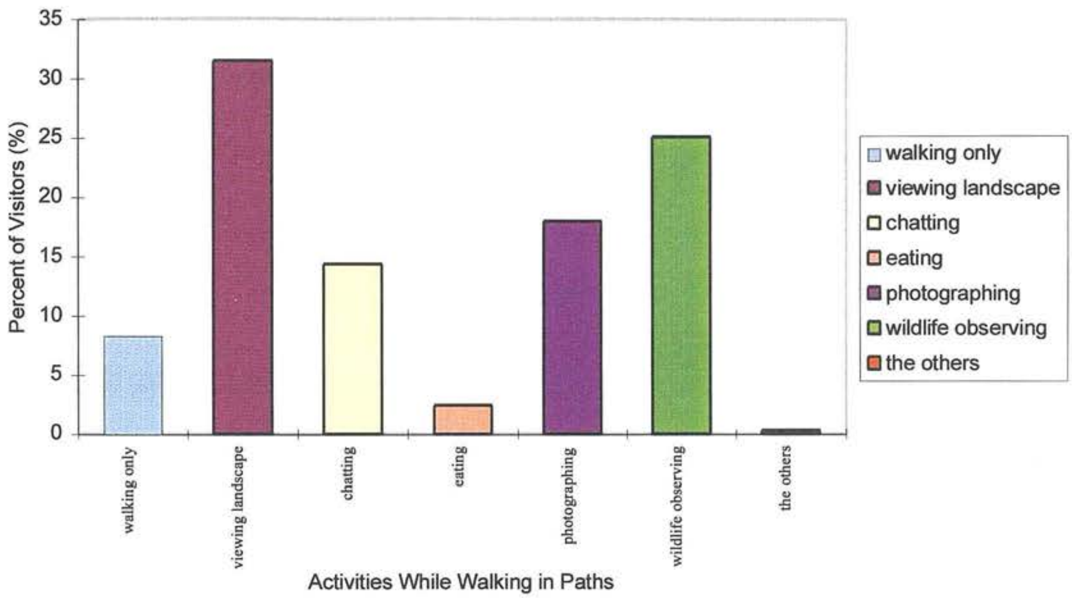


Figure 4.16 Visitor activities whilst walking along selected pathways

4.3.5 Facilities Preferences/ Improvement

Visitors were asked where they expected the public facilities like toilets, bins, etc. to be placed. The results reveal that more than half of the visitors (62.7%) preferred the facilities built right by the side of pathways ($P< 0.001$) (Figure 4.17).

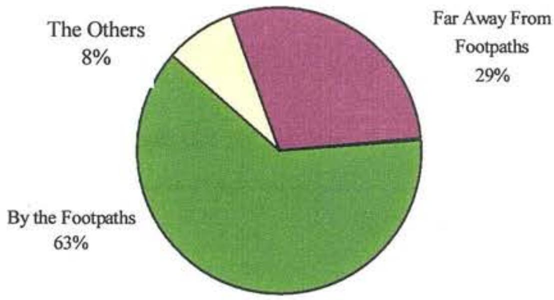


Figure 4.17 Visitor preferences for the location of new facilities. (χ^2 = 96.8019, DF=2, P <0.0001**)

43.7 percent of the visitors indicated there were sufficient signposts in the Park and that they were clear and easy to follow (NPAR χ^2 =46.9249 & DF=3, P< 0.0001**).

4.3.6 Willingness to pay

Two WTP questions were asked, if visitors were willing to pay in order to have less people in the Park and how much would they be willing to pay for lower visitor density. Initially, visitors were asked that if the visitor density in the park was to decrease, would they be willing to pay for this reduction. Results from the first question showed that 57.6 percent of the visitors *would* be willing to pay more ($P=.0272^* < 0.05$, significant). The second question, if the number of visitors decreased by half, showed that 23.1 percent of people would be willing to pay an increase in entrance fee of more than £0.50 (Table 4.26). If the number of visitors only was to decrease by a quarter, 24.8 percent people would be willing to pay the extra fee of more than £0.50 (Table 4.26). There were no significant differences between visitors' WTP for a decrease by 1/2 or 1/4 (Table 4.26).

Table 4.26 The extra fee which people would be willing to pay for less crowd density.

EXTRA FEE		DECREASE BY 1/2	DECREASE BY 1/4
New Taiwanese Dollars (NT$)	£ (Sterling)	Percent of Visitors	Percent of Visitors
NT$1-5	up to £.125	5.8%	24.8%
NT$6-10	up to £.25	28.9%	24.8%
NT$11-15	up to £.375	16.5%	9.9%
NT$16-20	up to £.5	25.6%	15.7%
>NT$20	> £.5	23.1%	24.8%
		χ^2=20.2810 , DF=4, P= .0004**	χ^2=11.4380 , DF=4, P= .0221*

Table 4.27 shows that the tolerance to crowd density in the Park is significantly different (P< 0.0001**). Analysis using the K-S Test showed that over 50 percent of visitors would refuse to come to Chitou when the crowd density increased to a certain point (Table 4.27). The rest of the visitors expressed that they would not be deterred from visiting the Park if the entrance fee remained the same, since they would visit Chitou avoiding peak season or peak time. The difference between these two groups of people is significant (K-S Test absolute differences value (χ^2) = .43330, 2-Tailed P (Significance) < 0.0001**). This statistical result supports the theory that visitors would refuse to come to Chitou when the crowd density increased to a certain point (1.6 times of current density).

Table 4.27 The tolerable crowd density in Chitou under current entrance fee. The Crowding Tolerance was 1.6 times of current density.

More Visitors	Percentage of Visitors	Total Percent of Visitors	Crowding Tolerance
1/6 of Visitors More	5.8%	53.8%	1.6
1/4 of Visitors More	9.1%		
1/2 of Visitors More	17.3%		
2 Times of Visitors	21.6%		
No Effect	46.2%	46.2%	
NPAR χ^2=105.5096, DF=4, P< 0.0001**		χ^2= .43330, 2-Tailed P< 0.0001**	

where

Crowding Tolerance
$= (1^1/_6 * 5.8\% + 1^1/_4 * 9.1\% + 1^1/_2 * 17.3\% + 2 * 21.6\%) / 53.8\%$
= 1.6 (times of current density)

4.4 PRIMARY RESULT OF LANDSCAPE PREFERENCES

In order to explore the preferences of respondents to landscape, a survey questionnaire was produced to assess visitor reaction to landscape components. 126 visitors to the Park were interviewed. In the first part of this survey, landscape themes (Footpath Surface Preference, Forest Preference, Crowd Density Preference, Colour Preference, Presence/Absence of Bridge and Water Features, Forest Structure Preference) were studied, in the second part, landscape scales were divided into Landscape Feature Preference and Landscape Psychological Preference.

4.4.1 Landscape Themes

To examine the preference to the 6 landscape themes, the Landscape Component Preference questionnaire and 6 colour photograph sets were given to visitors. Initially, visitors were asked to point out their favourite photograph from each of the 6 sets presented (Table 4.28).

Table 4.28 Nonparametric Chi-Square test for the preference to photograph sets 1-6.

Photograph Set		Percent of Visitors	χ^2	DF	P
SET 1	1 tar road	13.4	136.7778	3	< .0001
(Road Surface)	2 slabs of stone	59.3			
	3 pebble road	16.7			
	4 earth road	10.6			
SET 2	1 conifer	23.1	13.9630	3	.0030**
(Forest Types)	2 broad -leaved	26.9			
	3 mix forest	16.2			
	4 bamboo forest	33.8			
SET 3	1 many people	6.0	103.6944	2	<.0001
(Crowd Density)	2 less people	31.5			
	3 no people	62.5			
SET 4	1 pure green	44.4	2.6667	1	.1025
(Colour)	2 colour changing	55.6			
SET 5	1 water/bridge	95.8	180.5070	1	<.0001
(Bridge/Water)	2 no water/bridge	4.2			
SET 6	1 multi-storied F.	21.8	68.9074	1	<.0001
(Forest Structure)	2 single-storied F.	78.2			

(*: P < 0.05, significant; **: P< 0.0001)

In the second stage of the questionnaire, the level of preferences felt for each colour photograph was classified into 11 levels from -5 to +5, which represented partiality from 'strongly dislike' to 'strongly like' (Table 4.29). Visitors marked their preference extent for each photograph on this scale, such that all photographs were assigned a score.

Table 4.29 Nonparametric Chi-Square test for the comparison between Photograph Sets

Photograph Features	Features Comparison Pairs	χ^2	DF	P
SET 1	slab > tar	62.427	1	<.0001
(Road Surface)	pebble > tar	0.754	1	.3853
	tar >earth	0.692	1	.4054
	slab > pebble	51.610	1	<.0001
	slab > earth	73.013	1	<.0001
	pebble > earth	2.864	1	.0906
SET 2	bamboo > conifer	4.301	1	.0381*
(Forest Types)	broad-leaf>mixed forest	5.688	1	.0171*
	bamboo> broad-leaf	1.718	1	.1900
	bamboo> mixed forest	13.370	1	.0003**
	conifer >mixed forest	2.648	1	.1037
	broad-leaf > conifer	0.593	1	.4414
SET 3	less people > many people	37.346	1	<.0001
(Crowd Density)	no people > many people	100.568	1	<.0001
	no people > less people	22.113	1	<.0001

(*: significant, P< .05; **: extremely significant, P< .0001)

4.4.1.1 Theme 1: Footpath Surface Preference

Of the four kinds of footpath surface including tar roads, slate roads, pebble roads and earth roads, a majority of visitors (59.3%) preferred slate roads over the other types (all P<0.0001) (Table 4.28) (Figure 18(A)).

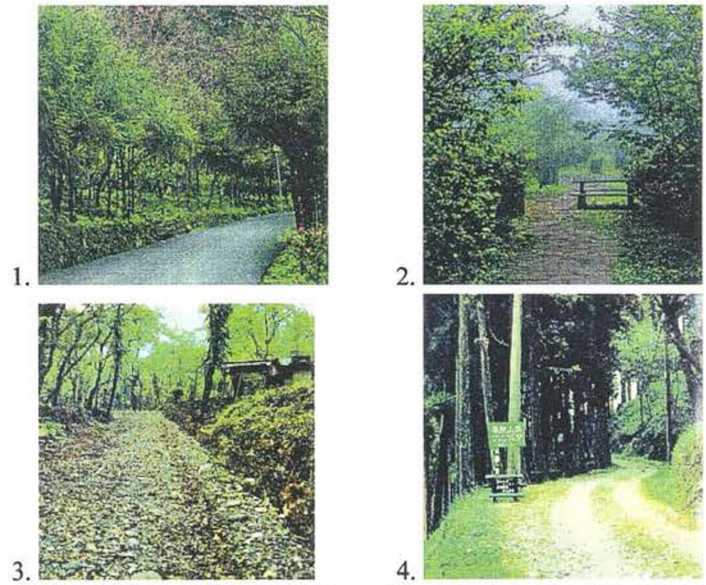


Figure 4.18(A) The colour photographs adopted for the 'Landscape Component Questionnaire'. Theme 1. Four kinds of footpaths (tar roads, slab roads, pebble roads and earth roads).

4.4.1.2 Theme 2: Forest Preference

There were highly significant difference between the preferences of visitors to the four types of forest (conifers; broad-leaved; mixed and bamboo) ($\chi^2 = 13.9630$, DF= 3, P= .0030**) (Table 4.28) (Figure 4.18(B)).

1.  2. 

3.  4. 

Figure 4.18(B) The colour photographs adopted for the 'Landscape Component Questionnaire'. Theme 2. Forest types (conifer, broad-leaved trees, mixed forest and bamboo).

Although there were no significant differences either between preference for conifers and mixed forest, conifer and broad-leaf or between broad-leaved forest and bamboo forest (Table 4.28), visitors preferred bamboo over mixed forest and conifers as well as preferring broad-leaf over mixed forest. Diagrammatic presentation of these results is illustrated below (Figure 4.18):

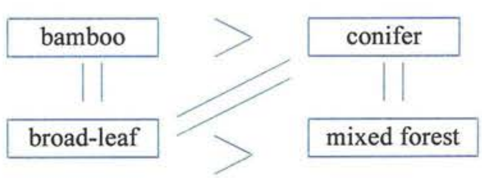


Figure 4.18 The preference of visitors to forest combination in the Park

4.4.1.3 Theme 3: Crowding Preference

The level of crowd density was divided into three levels: many, less and no people around the viewpoints and was represented in the way of colour photographs (PHOTOGRAPH SET 3) (Figure 4.18(C)).

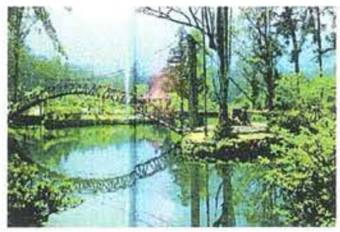
1.  2.  3. 

Figure 4.18(C) The colour photographs adopted for the 'Landscape Component Questionnaire'. Theme 3. Crowd Density (many people, less people and no people)

The result showed statistically significant differences between the preferences of visitors to the three levels of crowding (Table 4.28). Furthermore, as seen from Table 4.29, visitors strongly preferred 'no people' to 'less people', and strongly preferred 'less people' to 'many people'.

4.4.1.4 Theme 4: Colour Preference

In order to examine visitors' colour preferences, visitors were shown two colour photographs taken at the same place but in different seasons (Figure 4.18(D)). The result showed that visitors had no significant differences between preference for pure green and colour changing (Table 4.28). As visitors had only two photographs to compare, no further analysis of this theme was carried out.

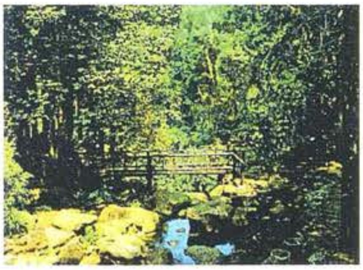
1.

2.

Figure 4.18(D) The colour photographs adopted for the 'Landscape Component Questionnaire'. Theme 4. Colour change (pure colour and colourful)

4.4.1.5 Theme 5: Presence/ Absence of Bridge and Water Features

When considering specific landscape preference, visitors illustrated a preference to the photograph which composed of both water bodies and bridges over a landscape containing neither elements (χ^2 = 180.5070, DF =1, P< 0.0001) (Table 4.28) (Figure 4.18(E)). Similar to PHOTOGRAPH SET 4, no further analysis was performed.



1.

2.

Figure 4.18(E) The colour photographs used for the 'Landscape Component Questionnaire'. Theme 5. Existence or not of water bodies and bridges

4.4.1.6 Theme 6: Forest Structure Preference

As Table 4.28 shows, visitors strongly preferred single-storied forest over multiple-storied forest (χ^2 = 68.9074, DF =1, P< 0.0001). Again, no further analysis was performed. The photographs used are shown in Figure 4.18(F).

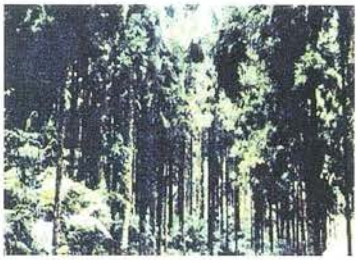
1.  2. 

Figure 4.18(F) The colour photographs used for the 'Landscape Component Questionnaire'. Theme 6. Forest Structure (multiple-storied and single-storied forest)

4.4.2 Landscape Scales

Apart from the Landscape Themes' study, the Scale of landscape was considered. Two comparisons were carried out in order to analyse further visitor preference to landscape components. Twelve additional colour photographs were classified evenly into two groups of Large Scale and Small Scale by the landscape combination. 216 visitors were asked to choose their most and least favourite photographs in both groups, respectively.

On choosing the 2 photographs (like/dislike), visitors were then asked to mark from a list of 15 landscape features (refer to Table 4.31) which one they preferred as their most favourite photograph and which one they disliked as the unfavourite photograph. This was done for two scales of photographs.

4.4.2.1 Landscape Feature Preferences in Large Scales

The 6 colour photographs chosen for Large Scale study are shown in Figure 4.19.

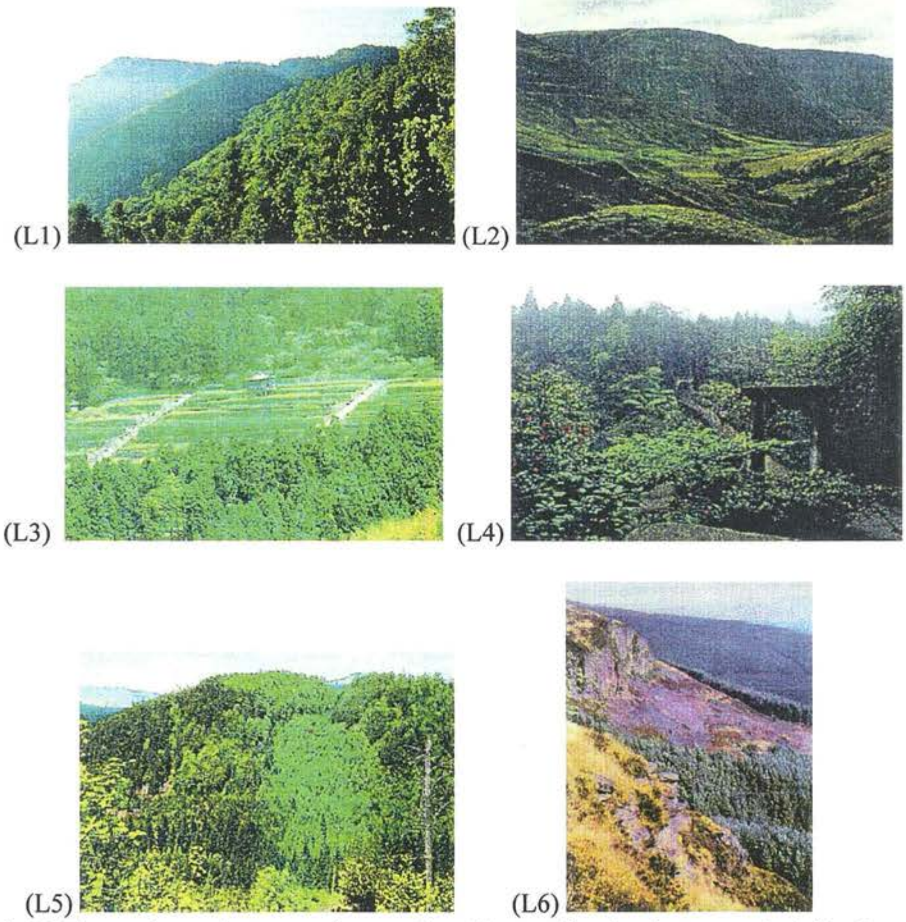


Figure 4.19 The colour photographs used as 'Large Scale photographs' for Landscape Scale study

As shown from Table 4.30, the choice of favourite and least favourite photographs from the six large scale photographs varied substantially and were significantly different from a random selection in both like and dislike cases (χ^2 = 86.7778, DF=5, P< 0.0001** and χ^2 = 333.8466, DF=5, P< 0.0001**, respectively). The most favoured large scale photograph was No. 2. In contrast, the least favoured large scale photograph was No. 6.

Table 4.30 The decrease order of preference for the most/ least favourite photograph in LARGE SCALE.

The Favourite Photograph	The Least Favourite Photograph
photograph 2 (33.3%)	photograph 6 (61.9%)
photograph 4 (25.9%)	photograph 3 (16.3%)
photograph 3 (17.1%)	photograph 5 (11.2%)
photograph 1 (14.4%)	photograph 2 (3.7%)
photograph 5 (6.9%)	photograph 4 (3.7%)
photograph 6 (2.3%)	photograph 1 (3.3%)

The most frequently selected three landscape components which visitors preferred in their favourite photograph in LARGE SCALE were 'Good Arrangement of Scenery', 'Natural Features' and 'Large Scale' (Table 4.31). On the other hand, the three features which were most frequently selected as being unattractive were 'Bad Arrangement of Scenery', 'Unnatural Features' and 'Eyesore'.

Table 4.31 The landscape components in the most and least favourite photographs in LARGE SCALE

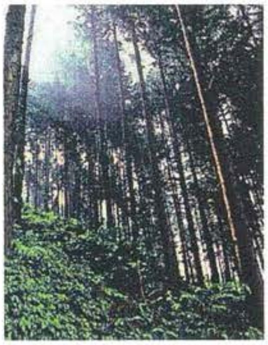
Landscape Components		***Percentage of Visitors***	
A	***B***	***The most favourite***	***The least favourite***
1. Water Body	**No Water Body**	9.7%	7.9%
2. Bridge	**No Bridge**	11.1%	0.9%
3. Good Arrangement of Scenery	**Bad Arrangement of Scenery**	25%	25.5%
4. Good Design of Footpaths	**Bad Design of Footpaths**	1.9%	2.8%
5. Good Material of Footpaths	**Bad Material of Footpaths**	-	1.9%
6. High Diversity of Landscape	**Low Diversity of Landscape**	8.8%	9.3%
7. Colourful	**Plain**	3.7%	3.7%
8. Conifers	**Broad-leaved Trees**	0.5%	1.4%
9. Natural Features	**Unnatural Features**	17.6%	17.6%
10. Mountains	**Plain**	1.9%	0.9%
11. Sky	**No Sky**	2.8%	0.5%
12. Eyesore	**No Eyesore**	1.4%	16.2%
13. Brightness	**Darkness**	1.4%	6.5%
14. Large Scale	**Small Scale**	13.4%	4.6%
15. The Others		0.5%	0.5%
		(χ^2= 223.2977, DF=13, P< 0.0001)	(χ^2= 257.1944, DF=14, P< 0.0001)

4.4.2.2 The Preferences of Landscape Components to the photographs in Small Scale

Another six colour photographs in small scale are shown below scale (Figure 4.20).

(S1) 

(S2) 

(S2) 

(S4) 

(S5) 

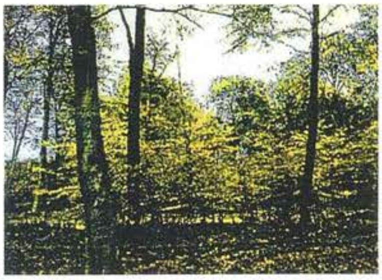
(S6) 

Figure 4.20 The colour photographs used as 'Small Scale photographs' for Landscape Scale study

The preferences of visitors to the six most liked and the six least favourite landscape photographs in small scale had very significant differences (favourite photograph- χ^2= 94.3333, DF=5, P <0.0001**; least favourite- χ^2 = 170.4444, DF=5, P <0.0001**). (Table 4.32).

Table 4.32 The visitor preferences to the most and the least favourite photographs in SMALL SCALE.

The Most Favourite Photographs	**The Least Favourite Photographs**
photograph 4(34.7%)	photograph 5(43.1%)
photograph 2(28.2%)	photograph 1(30.1%)
photograph 6(14.4%)	photograph 2(10.2%)
photograph 1(9.7%)	photograph 6(9.7%)
photograph 3(8.3%)	photograph 4(3.7%)
photograph 5(4.6%)	photograph 3(3.2%)

The most frequently selected small scale components which visitors preferred were 'Water bodies'(30.1%), 'Good arrangement of scenery' (28.7%) and 'Natural features'(15.3%) (Table 4.33). The three components which visitors found most unattractive were 'Bad Arrangement of Scenery'(27.8%), 'Unnatural Features' (17.1%) and 'Eyesore'(12.5%). This result is the same as that obtained from the photograph preference analysis in LARGE SCALE.

Table 4.33 The features in the most and least favourite photographs in SMALL SCALE

Alternatives		**Percentage of Visitors**	
A	***B***	***The most favourite***	***The least favourite***
1. Water Body	No Water Body	30.1%	4.2%
2. Bridge	No Bridge	0.5%	1.9%
3. Good arrangement of Scenery	Bad Arrangement of Scenery	28.7%	27.8%
4. Good Design of Footpaths	Bad Design of Footpaths	6.9%	6.9%
5. Good Material of Footpaths	Bad Material of Footpaths	1.9%	1.9%
6. High Diversity of landscape	Low Diversity of landscape	7.4%	7.4%
7. Colourful	Plain	2.8%	1.9%
8. Conifers	Broad-leaved Trees	3.2%	0.5%
9. Natural Features	Unnatural Features	15.3%	17.1%
10. Mountains	Plain	0.5%	-
11. Sky	No Sky	0.9%	1.9%
12. Eyesore	No Eyesore	-	12.5%
13. Brightness	Darkness	0.9%	6.9%
14. Large Scale	Small Scale	0.9%	8.3%
15. The Others		-	0.5%
		(χ^2= 371.0463, DF=12, P< 0.0001)	(χ^2= 232.6744, DF=13, P< 0.0001)

4.4.2.3 Quantification of Landscape Psychological Preference

Using the same 12 Landscape Feature Preference photographs, an investigation of landscape aesthetic feelings was carried out. Shown below is a list of 15 pairs of Landscape Psychological Features which were used to examine which feature in each comparison pair was preferred;

1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale
2. Common 5 4 3 2 1 2 3 4 5 Unusual
3. Angular 5 4 3 2 1 2 3 4 5 Rounded
4. Bright 5 4 3 2 1 2 3 4 5 Dull
5. Hard 5 4 3 2 1 2 3 4 5 Soft
6. Open 5 4 3 2 1 2 3 4 5 Close
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous
8. Natural 5 4 3 2 1 2 3 4 5 Man-made
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value
11. Interesting 5 4 3 2 1 2 3 4 5 Boring
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant

Interviewees were asked to score each of their most and least favourite photographs for each feature. In this way, visitor landscape perception was identified. The respondents were asked to mark on the scale to show where their preference lay. For example, *Bright 5 4 3 2 1 2 3 4 5 Dull* represents two extremes (5's). The 1 on the scale represents an undecided opinion as to which of the variables are preferred (Appendix C- the 'Landscape Component Questionnaire'). The results to the like and dislike photographs for both of the Large and Small Scales are summarised separately.

(I) <u>The Preference Extent to the Most Favourite Photograph in LARGE SCALE</u>

For each of the 6 preferred large scale photos, (the analysis procedures are listed in Appendix I (A)), a summary of the results has been included below.

A. Photograph 1

Features including *Natural, High Scenic Value, Beautiful and Pleasant* which were found in photograph 1 were strongly preferred (P< .0001**) (Table 4.34).

Table 4.34 A summary of the Landscape Psychological Preference results for each of the 6 large scale photos

Photographs	Strongly Preferred Landscape Perception (P<.0001)	Preferred Landscape Perception (P<.01)	Undecided Comparison Pairs (P>.05)
Photograph 1	*Natural, High Scenic Value, Beautiful and Pleasant*	*Large Scale, Bright, Open, Colourful and Peaceful*	*Common and Unusual, Angular and Rounded, Hard and Soft, Varied and Monotonous, Interesting and Boring, Obvious and Mysterious*
Photograph 2	*Large Scale, Bright, Open, Varied, Natural, Colourful, High Scenic Value, Interesting, Obvious, Beautiful, Peaceful and Pleasant*	*Soft*	*Common and Unusual, Angular and Rounded*
Photograph 3	*Large Scale, Angular, Bright, High Scenic Value, Interesting, Beautiful and Peaceful*	*Obvious*	*Common and Unusual; Hard and Soft; Open and Close; Varied and Monotonous; Natural and Man-made; Colourful and Colourless, Pleasant and Unpleasant*
Photograph 4	*Large Scale, Angular, Varied, Colourful, High Scenic Value, Interesting, Beautiful, Peaceful and Pleasant*	*Bright, Open and Natural*	*Common and Unusual, Hard and Soft, Obvious and Mysterious*
Photograph 5	*High Scenic*	*Peaceful*	the rest of the comparison pairs
Photograph 6	-	-	All the of the comparison pairs

B. Photograph 2

There were highly significant preference differences to most of the comparison pairs for Photograph 2. Visitors very highly preferred *Large Scale, Bright, Open, Varied,* *Natural, Colourful, High Scenic Value, Interesting, Obvious, Beautiful, Peaceful and Pleasant* (P < .0001**) (Table 4.34).

C. Photograph 3

For the photograph 3, visitors strongly preferred the characters of *Large Scale, Angular, Bright, High Scenic Value, Interesting, Beautiful and Peaceful* (P< .0001**) (Table 4.34).

D. Photograph 4

Visitors strongly preferred the characters of *Large Scale, Angular, Varied, Colourful, High Scenic Value, Interesting, Beautiful, Peaceful and Pleasant* in the photograph 4 (P < .0001**) (Table 4.34).

E. Photograph 5

Visitors very highly preferred the character of *High Scenic* in photograph 5 (P< .0001**) (Table 4.34).

F. Photograph 6

As Table 4.34 shows, the preferences to the 15 landscape perception comparison pairs for the Photograph 6 in large-scale had no significant differences. All the statistical observed levels for these pairs were greater than 0.05.

(II) The Preference Extent to the Least Favourite Photograph in LARGE SCALE

For each of the 6 least favourite large scale photos, (the analysis procedures are listed in Appendix I (B)), the results have been summarised as follows.

A. Photograph 1

As shown in Table 4.35, the dislike of visitors for the psychological perception of landscape photograph 1 showed no significant differences in each pair (P > .05) (Table 4.35).

Table 4.35 A summary of the least favoured Landscape Psychological Preference results for each of the 6 large scale photos

Photographs	Strongly Preferred Landscape Perception (P<.0001)	Preferred Landscape Perception (P<.01)	Undecided Comparison Pairs (P>.05)
Photograph 1	-	-	All the of the comparison pairs
Photograph 2	-	-	All the of the comparison pairs
Photograph 3	*Common, Monotonous, Man-made (Artificial), Obvious and Ugly*	*Bright, Low Scenic Value and Crowded*	the rest of the comparison pairs
Photograph 4	-	-	All the of the comparison pairs
Photograph 5	-	*Natural and Low Scenic Value*	the rest of the comparison pairs
Photograph 6	*Angular, Hard, Monotonous, Man-made, Colourless, Low Scenic Value, Boring, Obvious, Ugly, Crowded* and *Unpleasant*	*Dull*	All the of the comparison pairs

B. Photograph 2

Visitors didn't show significant differences to the dislike of each landscape perception pair. All the statistically observed significance levels were greater than 0.05 (Table 4.35).

C. Photograph 3

Visitors strongly disliked the characters of *Common, Monotonous, Man-made (Artificial), Obvious and Ugly* in photograph 3 (P< .0001**) (Table 4.35).

D. Photograph 4

Visitors' dislike characters in each pair among 15 comparison pairs had no significant differences (all P> .05) (Table 4.35).

E. Photograph 5

Visitors disliked *Natural and Low Scenic Value* in photograph 5 (P <.05) (Table 4.35).

F. Photograph 6

For the other comparison pairs, visitors disliked the landscape characters of *Angular, Hard, Monotonous, Man-made, Colourless, Low Scenic Value, Boring, Obvious, Ugly, Crowded* and *Unpleasant* (P< .0001**) (Table 4.35).

(III) <u>The Preference Extent to the Most Favourite Photograph in SMALL SCALE</u>

The Landscape Psychological Preference to six small scale photographs was also examined. Similar to the design of questionnaire for LARGE SCALE, visitors were asked to mark the scales of like or dislike from the 9 preference scales in 15 landscape psychological perception comparison pairs for the characteristics in their most favourite photographs. The scales were identical to those used previously (5's expressed two extremes (strongly like) to the two compared psychological features, while a score of 1 expressed neutral opinion (undecided)). The results of the 15 comparison pairs of landscape psychological preferences have been summarised below (Table 4.36), and the analysis procedures are listed in Appendix I (C);

A. Photograph 1

Visitors liked the features of *Bright* and *Colourful* ($P < .05$), however, they had no significant differences to preferences of the other characteristics in the rest of the 13 comparison pairs (Table 4.36).

Table 4.36 A summary of the Landscape Psychological Preference results for each of the 6 small scale photos

Photographs	Strongly Preferred Landscape Perception (P<.0001)	Preferred Landscape Perception (P<.01)	Undecided Comparison Pairs (P>.05)
Photograph 1	-	*Bright* and *Colourful*	the rest of the comparison pairs
Photograph 2	*Bright, Varied, Natural, High Scenic Value, Interesting, Beautiful, Peaceful, Pleasant*	*Common, Open* and *Colourful*	*Large Scale and Small Scale, Angular and Rounded, Hard and Soft, Obvious and Mysterious*
Photograph 3	-	*Unusual*	the rest of the comparison pairs
Photograph 4	*Rounded, Bright, Natural, High Scenic Value, Interesting, Beautiful, Peaceful* and *Pleasant*	*Large, Open* and *Colourful*	the rest of the comparison pairs
Photograph 5	-	*Interesting*	the rest of the comparison pairs
Photograph 6	*Large, Soft, Natural, Colourful, High Scenic Value, Beautiful, Peaceful* and *Pleasant*	*Rounded*	the rest of the comparison pairs

B. Photograph 2

Visitors highly preferred the landscape psychological characters in photograph 2 such as *Bright, Varied, Natural, High Scenic Value, Interesting, Beautiful, Peaceful, Pleasant* (P< .0001**) (Table 4.36).

C. Photograph 3

Visitors liked the character of *Unusual* in photograph 3 (P< .05). For the other features in the rest of the comparison pairs, the visitors did not show significant differences of preferences in between, respectively (Table 4.36).

D. Photograph 4

Visitors strongly preferred (P < .0001**) the landscape characters in photograph 4 such as *Rounded, Bright, Natural, High Scenic Value, Interesting, Beautiful, Peaceful* and *Pleasant*.

E. Photograph 5

The feature, *Interesting* in Photograph 5 was preferred (P < .05). For the other features no preference showed significant differences (Table 4.36).

F. Photograph 6

Visitors very strongly preferred the characteristics of *Large, Soft, Natural, Colourful, High Scenic Value, Beautiful, Peaceful* and *Pleasant* in photograph 6 (P< .0001**) (Table 4.36).

(IV) <u>The Preference Extent to the Least Favourite Photograph in SMALL SCALE</u>

The results of the 15 comparison pairs of landscape psychological responsed to each of the visitors' least favoured photographs have been summarised below (Table 4.37), and the analysis procedures were listed in Appendix I (D);

A. Photograph 1

Visitors strongly disliked the landscape psychological characters of *Small, Common, Angular, Bright, Monotonous, Man-made, Low Scenic Value, Boring, Obvious, Ugly, Crowded* in photograph 1(P< .0001**) (Table 4.37).

Table 4.37 A summary of the least favoured Landscape Psychological Preference results for each of the 6 small scale photos

Photographs	Strongly Preferred Landscape Perception (P<.0001)	Preferred Landscape Perception (P<.01)	Undecided Comparison Pairs (P>.05)
Photograph 1	*Small, Common, Angular, Bright, Monotonous, Man-made, Low Scenic Value, Boring, Obvious, Ugly, Crowded*	*Hard* and *Close*	*Colourful and Colourless, Pleasant and Unpleasant*
Photograph 2	-	*Mysterious* and *Unpleasant*	the rest of the comparison pairs
Photograph 3	-	-	All the of the comparison pairs
Photograph 4	-	-	All the of the comparison pairs
Photograph 5	*Small, Common, Angular, Dull, Soft, Close, Natural, Colourless, Low Scenic Value, Boring, Mysterious, Ugly, Peaceful* and *Unpleasant*	*Monotonous*	-
Photograph 6	-	-	All the of the comparison pairs

B. Photograph 2

The landscape psychological characters of *Mysterious* and *Unpleasant* in photograph 2 were disliked (P< .05). There was no significant differences of dislike for the other features in each set among the rest of the 13 comparison pairs (Table 4.37).

C. Photograph 3

Only 7 interviewees selected Photograph 3 in SMALL SCALE as their least favourite. As Table 4.37 showed, there were no significant differences of dislike to the landscape psychological characters in each pair for all the comparison pairs ($P > .05$).

D. Photograph 4

There was no significant differences between the dislike between each landscape psychological comparison pair for each of the 15 comparison pairs in photograph 4 ($P > .05$) (Table 4.37).

E. Photograph 5

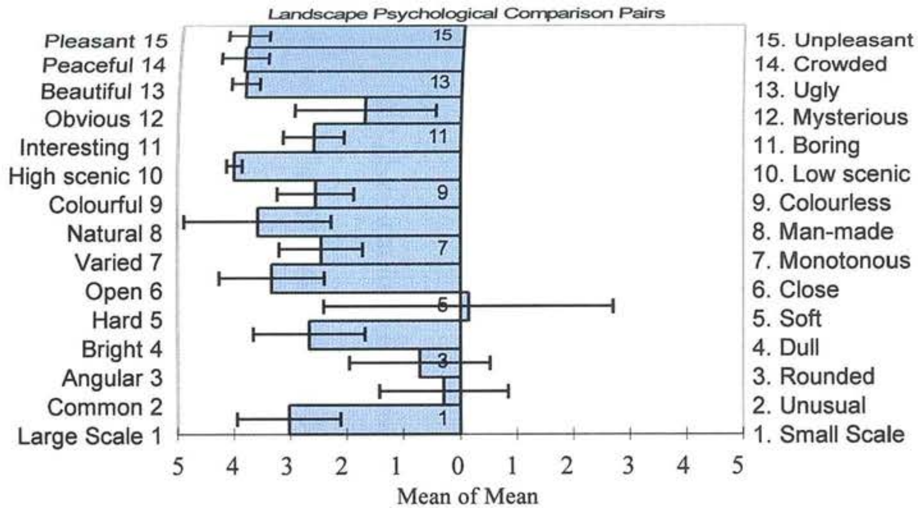
43 percent of visitors chose small scale Photograph 5 as their least favourite one. On analysis, it was found that visitors disliked the features of *Small, Common, Angular, Dull, Soft, Close, Natural, Colourless, Low Scenic Value, Boring, Mysterious, Ugly, Peaceful* and *Unpleasant* ($P < .05$) (Table 4.37).

F. Photograph 6

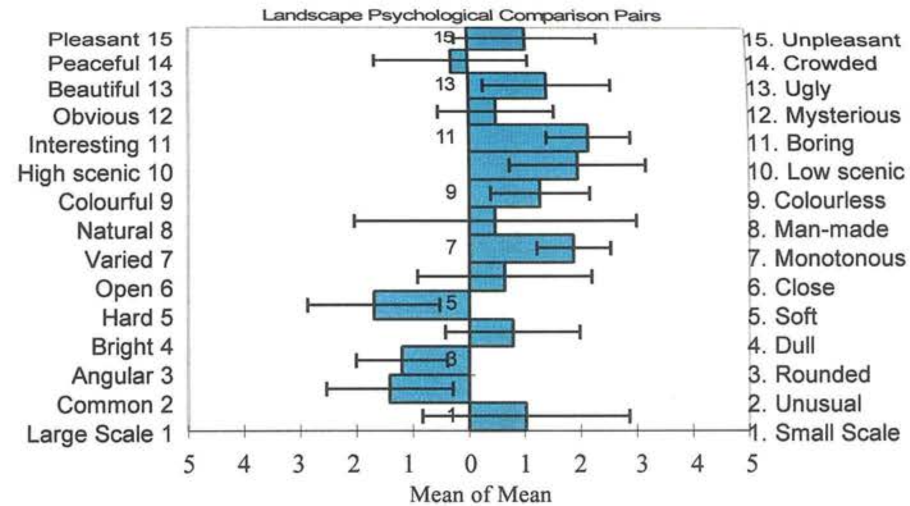
21 visitors considered photograph 6 as their least favourite photograph. There were no significant differences of dislike between the features of each pair among 15 landscape psychological comparison pair in photograph 6 (all $P > .05$) (Table 4.37).

(V) Summary of the Landscape Perception Quantification

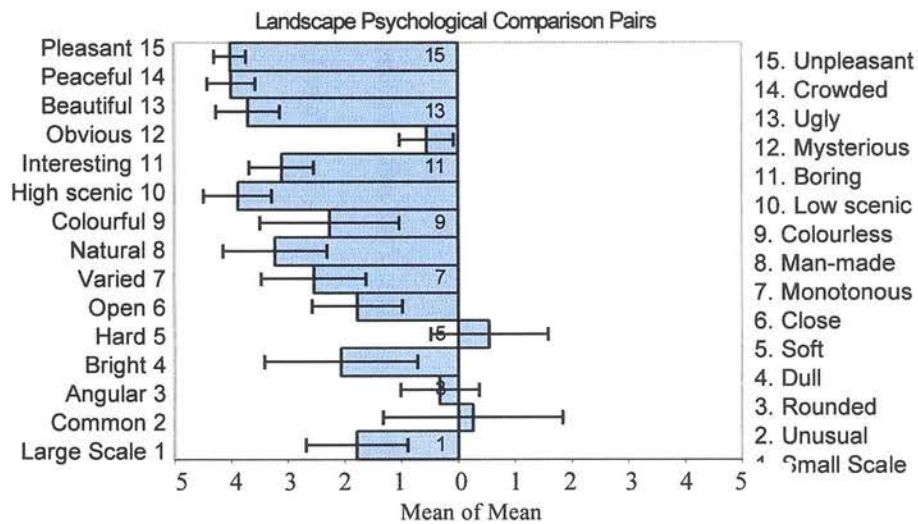
As a summary of the above, results showed that landscape photographs chosen as the favourite or least favourite by the majority visitors tended to represent a strong psychological preference. In other words, the results found that the preference scales were marked as extremes (near one of two of each scale, meaning strongly like). This is in contrast to the photographs chosen only by a few visitors as their most or least favourite landscape photographs which represented very intermediate psychological responses. In this case, the preference results tended to be near the middle of the scale (due to the insufficient valid questionnaire response of these least popular photographs, a standard statistical comparison could not be made). Using the mean of means, the results have been graphed to illustrate this (Figure 21). Analysis of perceptions to the favourite landscape photographs revealed that attributes such as *bright, pleasant, colourful, interesting,* and *varied* were important. Comparatively, for the least favourite photographs, negative impressions of the landscape were associated. These attributes included *dark, colourless, monotonous,* and *boring* etc. As the error bars in Figure 4.21 show, most feelings to the landscape features obtained from the favoured photographs no matter in Large or Small Scales had more reliable results.



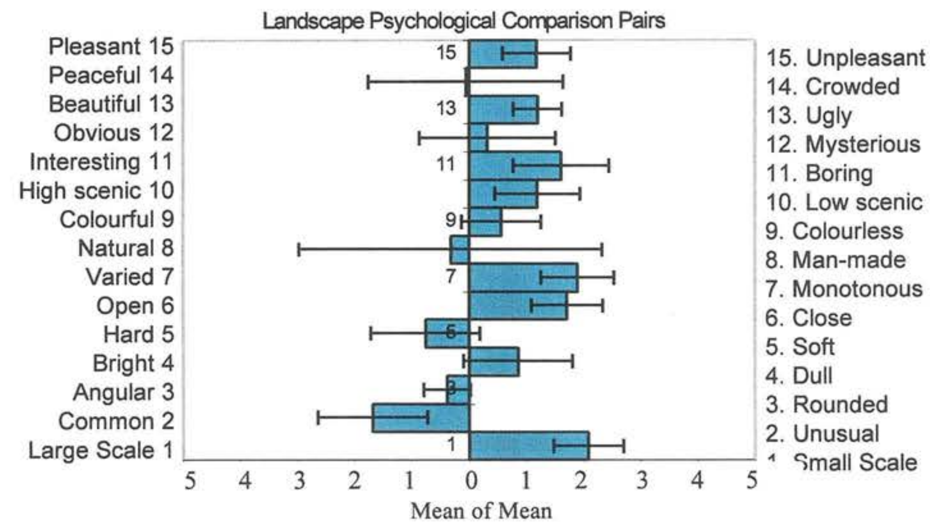
(a) Means of 6 favoured photographs in Large Scale



(b) Means of 6 unfavoured photographs in Large Scale



c) Means of 6 favoured photographs in Small Scale



(d) Means of 6 unfavoured photographs in Small Scale

Figure 4.21 The mean of the 6 photographs' means for each of the 15 Landscape Psychological pairs

4.5 Overall Summary of Primary Results

The results of this Chapter have been summarised in terms of Satisfaction, Crowd Intensity, Landscape Component Preference and Willingness to Pay.

4.5.1 'Satisfaction' study

Result from the 'Satisfaction' study show that the most important factors affecting visitors' decisions on which park to visit was the amenity of the landscape, low visitor density and good path conditions. Once there, visitors expressed that the Park's most impressive factors included a cool and quiet environment, attractive landscapes and the strong conservation ethics of Chitou. The importance of landscape was shown from both results. Although, in general, most visitors considered the viewpoint quantity to be sufficient, when questioned, many would have welcomed an increase in viewpoints in the Park. More footpaths were also an desired improvement.

Visitors preferred bamboo and natural forest types; simple structures were listed in both the panoramic landscapes and in the 'path landscape' (plantation arrangements along paths). Results showed that visitors favoured green colour in high proportion in the forest and landscape with seasonal colour changes.

Visitors would like to have more information about the Park, viewpoints, wildlife and ecological conservation. Most visitors would visit the Park again but at what time was not known (free time).

4.5.2 'Crowd Intensity' study

The average number of visitors in the Park at the popular viewpoints could be up to 350 (where the areas are about 1 ha) during peak times. Fifty percent of visitors said they felt crowded. More than 90 percent said they had experienced over-crowding at certain viewpoints (90.7%) and along footpaths (94.4%). The majority of visitors (59.4%) would ideally like to meet less than 10 other persons along paths at any one time, and just under half of the visitors (44.5%) thought that more footpaths would improve the crowding situation. Many identified BLOCK 7, in which *the University Pond* is located, as requiring footpath improvement. If the entrance fee remain the same, 46.2 percent visitors would continue to visit Chitou even if visitors kept on increasing to double the current amount.

Visitors mostly preferred a staircase and secondly, a tar surface road. In general, visitors were satisfied with the footpaths in the Park. The mean satisfaction extent was +2.6 with the range from -5 to +5. For the design of the footpaths, visitors preferred wide (> 1m) and winding footpaths. The most heavily used and the most popular footpaths was pathway 2, this is linked to *the University Pond* viewpoint. This coincided with the reason for which the visitors had chosen certain pathways considering their viewpoint- interest.

While walking along footpaths, visitors liked to see natural woodland, water bodies/ bridges and wildlife. The activities visitors usually undertook on the footpaths were viewing the landscape and observing wildlife. The majority of visitors would like to have facilities built right by the side of pathways.

4.5.3 'Landscape Component Preference' study

This 'Landscape Component Preference' study adopted colour photographs which were split into Landscape Themes and Landscape Scales. Results of 6 photograph comparison sets showed that visitors most preferred the slate road surfaces; bamboo and broad-leaved forest types; 'less visitors'; having both water bodies and bridges in the landscape; and preferred single-storied forest stands. The preference between photographs showing pure green and changing-colour had no significant differences.

The most favoured Large Scale photograph was No. 2, the least favoured was No. 6. The most favoured Small Scale photograph was No. 4 and the least favoured one was No. 5. Results showed that favoured features for both Large Scale and Small scale photographs were 'Water body', 'Good Arrangement of Scenery' and 'Natural Features'.

The Landscape Psychological Preference features for the most and the least favourite photographs were identified. The photographs chosen by the majority of the visitors tended to have a strong psychological response. As the graphs (Figure 4.21) show, the results were clustered at one end of the scale or the other. These most and least favoured photographs chosen by a minority of visitors showed neutral psychological responses. For the most favoured photographs, the psychological features such *as bright, pleasant, colourful, interesting,* and *varied* were considered. For the least favoured photographs, the psychological features including *dark, colourless, monotonous*, and *boring* etc. were the affective factors.

4.5.4 WTP issues

Most of the visitors felt the current entrance fee (£2.50) was reasonable and nearly 80 percent of visitors would be willing to pay more than £0.50 extra for more or better viewpoints. The majority of visitors would pay more than £0.50 extra for more extensive ecological conservation activities.

More than half of the respondents (57.6%) would be willing to pay for less visitor density in the Park while 23.1 percent of those would be willing to pay an extra fee of more than £0.50 if the visitor density reduced by half, and 24.8 percent of those would be willing to pay an extra fee of more than £0.50 if the visitor density reduced by a quarter (see Table 4.26). There were no statistical differences in between. If the entrance fee was to remain the same, nearly half of the visitors (46.2%) would visit the Park again even if the visitor density was to double.

CHAPTER 5. THE PREDICTION OF RECREATION PERCEPTION AND ITS APPLICATION

5.1. Objective of the Prediction of Recreation Perception

Modern park management involves balancing of conservation goals with recreation provision. Investigating visitor recreation preferences and defining landscape components permits the achievement of these goals. The increased recreation in Taiwan and the popularity and potential development of Chitou highlight the need to understand and predict visitor recreation preferences and demands. Development of recreation management to supply more high quality recreation opportunities is balanced with the need to maintain ecological and aesthetic considerations.

This chapter considers the establishment of Recreation Preference Models (RPMs) for predicting visitor satisfaction and crowd intensity. Regression and Factor Analysis techniques are used to develop the regression models, based on a detailed survey of visitors to the park. The final two RPMs express the probability of occurrence in recreation enjoyment and amenity in terms of satisfaction and visitor density preferences. Other potential applications of the RPMs include planning logging and planting operations, landscape, pathway and conservation management. The GIS approach employed is discussed.

5.2 Outline of Methodology

5.2.1 Model Approach And Selection

Information on the general visitor recreation perception from the results of primary analysis was first gathered (refer to Chapter 4). The analyses presented in this chapter are the classification, quantification and prediction of visitor enjoyment and landscape preferences. The visitor Recreation Preference Models (RPMs) were developed for this purpose. RPMs were further attempted to integrate with GIS for recreational resource allocation. This attempt was based on visitors' willingness to pay for more attractions and lower visitor density LR (Dubgarrd, 1994; Holmes, 1995; Pruckner, 1995). To identify the best suited statistical methods, LINEAR REGRESSION ANALYSIS and LOGISTIC REGRESSION ANALYSIS were employed and compared. Following a FACTOR ANALYSIS, further LINEAR REGRESSION ANALYSIS was also carried-out to attempt to locate an improved model. To assist understanding of this methodology, Figure 3.3 is repeated here for convenience. The detailed methodology will then be described.

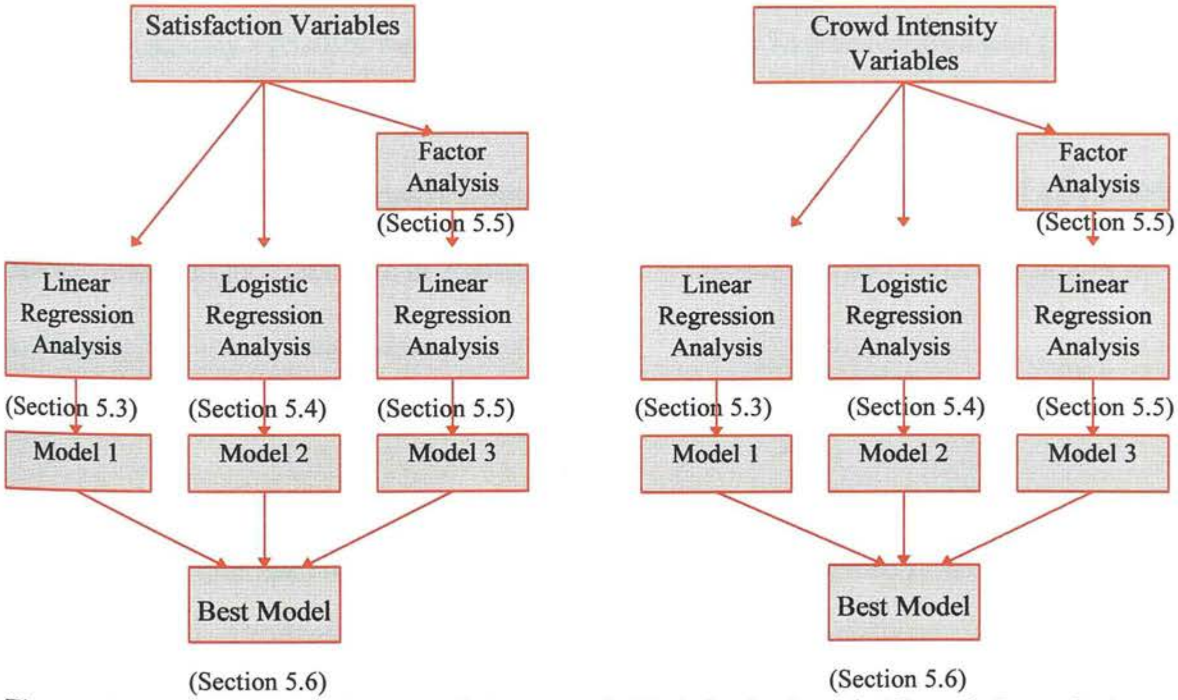


Figure 3.3 Diagram of the establishment of 'Satisfaction' and 'Crowd Intensity' models-methodology approach.

5.2.2 Data Preparation

The scale of collected data is not always the most suitable for analysis and interpretation. When the assumptions in the Analysis of Variance break down, transformation of the raw data to a different scale may yield an analysis for which the assumptions are valid (Mead, et al. 1993). Mead, et al. further stated that when treatment or block effects are likely to be proportional rather than additive the use of the log scale will often lead to a more valid analysis than the original scale. When the measurement of interest is some form of count or an area, then the square root transformation is often effective (Mead, et al. 1993). Both natural logarithm (abbreviated as LOG below) and square root (abbreviated as SQRT below) transformations were applied to the dependent variable of willingness to pay for more views.

Variable coding schemes for dummy-variables were conducted manually to some topographic variables concluding the variables of colour preferences, the variables of landscape complexity preferences as well as the variables of preferences to plantation types and their arrangement along paths. The dummy variables were used in LR and Logistic Regression Analysis (LRA). For the other variables with more than two categories, new dummy variables were created to represent the categories by using the variable coding schemes with SPSS. The definition of all variables are described in the Questionnaires in Appendix A and B and summarised variable lists can be found in Chapter 3 (Table 3.1 and 3.2).

5.3 Linear Regression Analysis (LR)

Linear Regression Analysis was used to estimate the coefficients of the variables of questionnaires to determine the predictors of visitor satisfaction and crowd perception. Both of the decision variables (independent variables) of visitor perceptions to the Park were identified and then analysed with a GIS. *Stepwise* variable selection method was adopted to control the way in which selected variables were entered into, and removed from, the regression equation. For the *stepwise* method, the variables with the lowest probability of F ($F < 0.05$) were entered and were removed if this probability of F was higher than 1.

5.3.1 Satisfaction Prediction Model (Appendix A)

A. LR Data Preparation for 'Satisfaction':

The variable for willingness to pay for more viewpoints (*wtpview*), has a positive meaning for visitor satisfaction and recreation demands (see the primary results in Section 4.2.7) and was used as a dependent variable against the other independent perception variables in LR. Visitors' WTP for more and better attractions was the point considered (Dubgarrd, 1994; Holmes, 1995; Pruckner, 1995). Both LOG and positive SQRT transformations were tested so that the best model could be developed.

Some independent spatial variables with more than two categories (scales) in themes of COLOUR, FOREST, LANDSCAPE COMPLEXITY and PATH PREFERENCES were manually coded into two categories (0 and 1) and a new dummy-variable was created for each of them, respectively (Table 5.1). The SPSS dummy variable coding schemes were adopted for the other independent variables (Norušis, 1993b, p11-14). These coding schemes include the default method, *deviation,* and *indicator* variable coding scheme. The independent variables such as the preferences for a high proportion of dark green in scenery is named *dark green_y* (scale 2-5 re-defined as 1) and the preference to low proportion of dark green in scenery is named *dark green_x* (scale 1 re-defined as 0) (Table 5.1).

Table 5.1 Dummy- variable coding scheme for landscape components

THEME	Original Variable	Dummy-variables	Scales	Coding*	Original Variable	Dummy-variables	Scales	Coding*
COLOUR	dark green	dark green_x	5	scale 1->0 scale 2-5->1	light green	light green_x	5	scale 1->0 scale 2-5->1
		dark green _y		scale 1-3->0 scale 4-5->1		light green_y		scale 1-3->0 scale 4-5->1
	yellow	yellow_x	5	scale 1->0 scale 2-5->1	red	red_x	5	scale 1->0 scale 2-5->1
		yellow_y		scale 1-3->0 scale 4-5->1		red_y		scale 1-3->0 scale 4-5->1
	orange	orange_x	5	scale 1->0 scale 2-5->1	brown	brown_x	5	scale 1->0 scale 2-5->1
		orange_y		scale 1-3->0 scale 4-5->1		brown_y		scale 1-3->0 scale 4-5->1
FOREST	forest1- man-made conifers	forest1_x	6	scale 0->0 scale 1-5->1	forest2- man-made broad-leaf	forest2_x	6	scale 0->0 scale 1-5->1
		forest1_y		scale 0-4->0 scale 5->1		forest2_y		scale 0-4->0 scale 5->1
	forest3- man-made mixed forest	forest3_x	6	scale 0->0 scale 1-5->1	forest4- bamboo	forest4_x	6	scale 0->0 scale 1-5->1
		forest3_y		scale 0-4->0 scale 5->1		forest4_y		scale 0-4->0 scale 5->1
	forest5- natural forest	forest5_x	6	scale 0->0 scale 1-5->1	forest6- lawn	forest6_x	6	scale 0->0 scale 1-5->1
		forest5_y		scale 0-4->0 scale 5->1		forest6_y		scale 0-4->0 scale 5->1
LANDSCAPE COMPLEXITY	landscape1- simple	landscape1_x	11	scale -5-0->0 scale 1-5->1	landscape2- less simple	landscape2_x	11	scale -5-0->0 scale 1-5->1
		landscape1_y		scale-5-+3->0 scale 3-5->1		landscape2_y		scale -5-+3->0 scale 3-5->1
	landscape3- less complex	landscape3_x	11	scale -5-0->0 scale 1-5->1	landscape4- complex	landscape4_x	11	scale -5-0->0 scale 1-5->1
		landscape3_y		scale-5-+3->0 scale 3-5->1		landscape4_y		scale -5-+3->0 scale 3-5->1
PATH PREFERENCE	pathplantl	pathplantl _x	6	scale 0->0 scale 1-5->1	pathplantd	pathplantd _x	6	scale 0->0 scale 1-5->1
		pathplantl _y		scale 0-3->0 scale 4-5->1		pathplantd _y		scale 0-3->0 scale 4-5->1

*(scale 1->0: scale 1 re-defined as 0; scale 2-5->1: scale 2-5 redefined as 1)

B. LR Result for 'Satisfaction':

Table 5.2 shows the final LR satisfaction model selected to predict the extra fee which visitors would be willing to pay for more views. The independent variables which were offered in the model can be classified into a few themes: (1) COLOURS: *dark green preferences, light green preferences, yellow preferences, red preferences, orange preferences, brown preferences*; (2) FOREST PREFERENCES: *man-made conifers preferences, man-made broad-leaved preferences, man-made mixed preferences, bamboo preferences, natural forest preferences* and *forest rest lawn preferences*; (3) LANDSCAPE COMPLEXITY: the *preferences for a simple landscape structure, less simple landscape structure, less complex landscape structure and complex landscape structure* and (4) the preferences to *brightness, the most favourite plant arrangement along paths* and *the least favourite plant arrangement along paths.* The final LR model (Equation 5.1) explained 58.37 percent of the visitors' opinions as shown by the R^2 figure given in Table 5.2. This provides a good fit when compared to current recreation perception research (Huang, 1989).

Table 5.2 The prediction model of visitor satisfaction perception to the Park using Linear Regression Analysis.

DEPENDENT VARIABLE	INDEPENDENT VARIABLES	B (co-efficient)	SIGNIFICANT	MULTIPLE R	R^2	F	SIGNIF F
wtpview	*dark green_y*	.133630	.0062	.76	.58	64.83594	< 0.001
	wtpviewyes	-.706697	.0000				
	wtpconserve	.152172	.0018				
	pure forest	.121629	.0123				

wtpview = *.133630dark green_y - .706697wtpviewes + .152172wtpconserve + .121629pure forest*

Equation 5.1

Where *wtpview*: extra fee which visitors would be willing to pay for more viewpoints
wtpviewyes: willingness to pay for more viewpoints or not
wtpconserve: willingness to pay for improved conservation
dark green_y: preference to a high proportion of dark-green; dummy-variables (_y)
pure forest: the preference to pure forest

As Table 5.2 shows, the preference to a high proportion of dark-green (*dark green_y*), the willingness to pay for improved conservation (*wtpconserve*), and the preference to pure forest (*pure forest*) have the positive effect for increasing the extra fee which visitors would be willing to pay for more viewpoints (*wtpview*). However, the independent variable, willingness to pay for more viewpoints or not (*wtpviewyes*), shows the unexpected negative relationship with the dependent variable.

5.3.2 <u>Visitor Density Preference Model</u> (Appendix B)

In order to examine preferences in visitor densities, the relationship between willingness to pay for less visitor density and the other independent variables was studied. If visitors are willing to pay for less visitor density, then it can be assumed that the visitor density was pretty high. Conversely, it means that the current visitor density was still below the maximum tolerance of visitors.

A. LR Data Preparation for 'Visitor Intensity':

Willingness to pay for half of the current visitor density (*Decrease1*) was used as the dependent variable. All independent variables here used the original variables without recoding. *Stepwise* variable selection method was again carried out. The variables with the lowest probability of F ($F < 0.05$) were entered and were removed if this probability of F was higher than 1.

B. LR Result for 'Visitor Intensity':

Two independent variables, "willingness to pay for less visitor density or not" and "willingness to pay for one quarter reduction from the current visitor density", were entered into the model as predictors by the LR *stepwise* variable selection method. As Table 5.3 shows, the extra fee which visitors would be willing to pay for a quarter reduction from the current visitor density (*Decrease2*) has a positive effect for increasing the extra fee which visitors would be willing to pay for half of the current visitor density (*Decrease1*) while the other independent variable, willingness to pay more money for less visitor density or not (*Decrease*), has a negative effect with the dependent variable (*Decrease1*). Although the best visitor density prediction model has a R^2 figure of 0.83 (Table 5.3), the two predictors show meaningless and have no spatial characteristics for subsequent mapping. Therefore, Equation 5.2 was not chosen as the final model for the prediction of visitor crowd perception. Another regression analysis, Logistic Regression Analysis, was therefore carried out in further search for the best solution.

Table 5.3 Linear Regression Analysis of Willingness to Pay for the limitation to half of the current visitors and the predictors using *stepwise* method.

DEPENDENT VARIABLE	INDEPENDENT VARIABLE	B (co-efficient)	SIGNIFICANT	MULTIPLE R	R^2	F	SIGNIF F
Decrease1	*Decrease*	-.4280	.0000	.91	.83	441.2172	< 0.001
	Decrease2	.5536	.0000				

$$Decrease1 = -.4280Decrease + .5536Decrease2 \qquad \textbf{Equation 5.2}$$

Where	*Decrease1*:	the extra fee which visitors would be willing to pay for half of the current visitor density
	Decrease :	willingness to pay more money for less visitor density or not?
	Decrease2 :	the extra fee which visitors would be willing to pay for a quarter reduction from the current visitor density

5.4 Logistic Regression Analysis (LRA)

Logistic Regression Analysis was used to estimate the coefficients of a probability model, involving a set of continuous or binary independent variables which best forecast the probability of an event (a binary dependent variable) occurring (Norušis, 1993b, p1-2). In this LRA modelling approach, both selected dependent variables for visitor satisfaction perception and visitor density preferences were designed as binary functions (yes/ no questions). Logistic regression models were therefore used to predict the probability of the occurrence of visitors' recreational preferences.

These models will be compared with the other models obtained from the other statistical analyses to approach the best results.

A. LRA Method Selection:

Here, the *Forward LR (Forward Stepwise selection)* method was used to control the entry of independent variables into the model. Removal testing is based on the probability of the likelihood-ratio statistics and on the maximum-likelihood estimates (Norušis, 1993b, p24). In Logistic Regression Analysis, *Forward LR* was functioned as a *stepwise* selection method in LR (Norušis, 1993b, p15). A variable was entered into the model if the probability of its score statistic was less than 0.05 and removed if the probability of its score statistic was greater than or equal to 0.10. For selecting the best model, various combinations of available independent variables and coding schemes for category variables were tried to predict the probability of visitor preference perception in terms of visitor satisfaction and visitor density preferences. *Deviation* and *Indicator* coding schemes were conducted, respectively, to transform categorical covariates and interaction terms into dummy-variables (Norušis, 1993b, p11-14). Including or suppressing constants in models were tested such that the best model system was developed.

5.4.1 Satisfaction Prediction Model: (Appendix A)

A. LRA Data Preparation for 'Satisfaction':

The LRA satisfaction prediction model research employed dummy variables to enhance the classification ability of Recreation Preference Models. Some independent variables including: (1) COLOUR: *the preferences to dark green,* the *preferences to light green, the preferences to yellow,* the *preferences to red,* the *preferences to orange,* the *preferences to brown;* (2) FORESTS: *the preferences to man-made conifers, the preferences to man-made broad-leaved, the preferences to man-made mixed, the preferences to bamboo, the preferences to natural forest, the preferences to forest rest lawn, the preferences to mixed forest and pure forest*; (3) LANDSCAPE COMPLEXITY: the *preferences to simple, less simple, less complex and complex landscape structure* and (4) *the preferences to brightness, the preferences to the most favourite plant arrangement along paths and the least favourite plant arrangement along paths* were coded into two categories (0 and 1) manually and a new dummy-variable was created for each of them, respectively (Table 5.1). For the other variables, SPSS dummy coding schemes including *Deviation* and *Indicator* contrast methods were adopted, respectively, to compare and obtain the best result.

B. LRA Result for 'Satisfaction':

The application of the models to examine recreation demands and landscape preferences required spatialisation of the relative predictors. Those independent spatial variables were extracted using LRA (Table 5.4). Overall, 62.7 percent of visitors were correctly classified by this model, that is, the model can represent 62.7 percent of visitors' opinions. Considering the complexity and uncertainty characteristics of social science studies, the result is satisfactory (Huang, 1989; Chen, 1988). The probability of visitors' satisfaction with the Park can be obtained from Equation 5.3. and the probability of visitors' dissatisfaction with the Park can be estimated as Probability (dissatisfaction) = 1 - Probability (satisfaction). As Table 5.4 shows, the predictors in the model include the preference for a high proportion of brownness in the scenery (*BROWN_Y*), for a high proportion of natural forest in the scenery (*FOREST5_Y*), for a high proportion of complex landscape in the scenery (*LANDSCAPE4_Y*), for a high proportion of orangeness in the scenery (*ORANGE_Y*) and for a high proportion of pure forest in the scenery (*PURE FOREST_Y*) are all topographic variables with landscape characteristics. The preference for a high proportion of complex landscape, for orangeness and for pure forest in the scenery have the positive effect for increasing the probability of visitors' satisfaction occurrence while the preference for a high proportion of brownness and for natural forest in the scenery have the negative effect of decreasing the probability of visitors' satisfaction with the Park.

These independent variables are mapped in the later stages for the final combination of recreation preferences. The coefficient of each independent variable determines the relative weights of their images in the mapping stages.

Table 5.4 The probability of visitor satisfaction occurrence in terms of willingness to pay for more views using Logistic Regression Analysis.

Dependent	**Contrast Method**	**B** (co-efficient)	**Predictor**	**Signif.**	**Overall** (% classified correctly from sample-derived prior probability)	**Chi-Square Sig.**
Satisfy	None	1.1283	*BROWN_Y*	.0219	**62.7%**	**.0424**
		0.6062	*FOREST5_Y*	.0439		
		-0.7708	*LANDSCAPE4_Y*	.0138		
		-1.5427	*ORANGE_Y*	.0031		
		-0.9182	*PURE FOREST_Y*	.0039		
		0.1965	*CONSTANT*	.3992		

Where *satisfy*: visitor satisfaction to the Park or not (in term of 'Satisfaction')
brown_y: high proportion preferences to brown; dummy-variables (_y)
orange_y: high proportion preferences to orange; dummy-variables (_y)
forest5_y: high proportion of preferences to natural forest; dummy-variables (_y)
landscape4_y: high proportion of preferences to complex landscape; dummy-variables (_y)
pure forest_y: high proportion of preferences to pure forest; dummy-variables (_y)

As the Logistic Regression Model is used to predict the probability of an event occurring or not, the LRA model for the visitor satisfaction occurrence to the Park (*satisfy*) will refer to the studies of Coker and Capen (1995) and Norušis (1993b) and be presented as-

PROBABILITY OF SATISFACTION (*satisfy*) **OCCURRENCE** = $\frac{1}{1+e^{-Z}}$ **Equation 5.3**

Where $Z = 0.1965 + 1.1283\ BROWN\_Y + 0.6062\ FOREST5\_Y - 0.7708\ LANDSCAPE4\_Y - 1.5427\ ORANGE\_Y - 0.9182\ PURE\ FOREST\_Y$

5.4.2 The Prediction Model of Visitor Density Preferences (Appendix B)

A. LRA Data Preparation for 'Crowd Intensity':

Variables including visitors' satisfaction perception to the footpaths in Chitou (*satisfy*) and visitors' perception to the intensive use in Chitou (*crowd*) were both used as dependent variables, respectively, to investigate the best prediction model for the probability of visitors' opinions to current intensive use in Chitou. This considered that visitor density could be an important indicator of visitors' satisfaction to footpaths, therefore, visitors' satisfaction perception to the footpaths was tested as a dependent variable in LRA. All the other independent variables including non- spatial variables were included in LRA model approaches for testing the best result. The reason of the employment and test of non-spatial independent variables concerns the interaction of the variables. They may have an important contribution to the classification of visitor characteristics.

B. LRA Result 1 for 'Crowd Intensity':

Table 5.5 was obtained using spatially independent variables. This model (Equation 5.4) is constructed using the independent variables including: the number of visitors who preferred pathway 14 (*P14*); the number of visitors who preferred pathway 15 (*P15*); the number of visitors who had visited pathway 13 (*SECTION 13*) and the number of visitors who felt the people density was too high at viewpoints (*CROWDVIEW*). The overall result represents 89.3 percent of visitors' characters. These predictors were either popular path routes or viewpoints. From the application of these pathways or views (Equation 5.4), it could predict the possibility of occurrence of visitors' satisfaction with the intensity of use in Chitou while expansion is considered to meet future visitors' demand. For example, the number of visitors who preferred pathway 15 has the positive association with the probability of visitors' crowd perception while the numbers of visitors who preferred pathway 14, 13 and the number of visitors who felt the people density was too high at viewpoints have the negative association with the probability of visitors' crowd perception. This model fits 89.3 percent of visitors' opinions.

Table 5.5. Logistic Regression Analysis of satisfaction to footpath and the predictors using SPSS *Forward: LR* method.

Dependent Variable	***B*** (co-efficient)	**Predictor**	**Significance**	**Overall** (% classified correctly from sample-derived prior probability)	**Chi-Square Sig.**	**Contrast Method**
Satisfy	3.0161	*P14*	0.0504	89.3%	.0183	None
	-3.3400	*P15*	0.0066			
	1.7103	*SECTION13*	0.0239			
	0.3863	*CROWDVIEW*	0.0000			

where *Satisfy*: visitors' satisfaction perception with the footpaths in Chitou (in term of 'Crowd Density')
P14: the number of visitors who preferred pathway 14
P15: the number of visitors who preferred pathway 15
SECTION13: the number of visitors who had visited pathway 13
CROWDVIEW: the number of visitors who felt the people density too high at viewpoints

The Logistic Regression Model for visitor crowd density occurrence by examining visitors' satisfaction perception with the footpaths in Chitou (*Satisfy)* is presented as-

$$\textbf{PROBABILITY OF CROWD DENSITY OCCURRENCE} = \frac{1}{1+e^{-Z}} \qquad \textbf{Equation 5.4}$$

Where $Z = 3.0161\ P14 - 3.3400\ P15 + 1.7103\ SECTION13 + 0.3863\ CROWDVIEW$

C. LRA Result 2 for 'Crowd Intensity':

In this LRA, all variables were employed and SPSS dummy coding schemes were carried out. When the variable of whether visitors felt crowded or not was selected as dependent variable, 11 independent variables from all variables were entered into the visitor density preference model by LRA. SPSS *Forward Stepwise* variable selection methods were adopted. The classification result, overall, could represent 73.4 percent of the visitors' characters (Table 5.6). No matter which dummy methods (*Deviation* or *Indicator*) were used, the results were the same for either approach. Although the classification result is not as high as the one in Table 5.5, it is high enough for the model to fit well.

As shown in Table 5.6, the independent variable for the visitor perception to the visitor density at the viewpoints in the Park was coded into six variables: the number of visitors who felt crowded at *Red Mansion*; the number of visitors who felt crowded at *Campsites*; the number of visitors who felt crowded at *Gingko Plantation*; the number of visitors who felt crowded at *the Great Spiritual Tree*; the number of visitors who felt crowded at *the University Pond* and the number of visitors who felt crowded at the other places not in the viewpoint list. All of them are the predictors of the visitor density model and have the positive affection to the probability of perception of intensive use. When more visitors felt crowded at these viewpoints, the probability of feeling crowded in Chitou will increase. The numbers of visitors who preferred pathway 12, 2, 22 and 23 are positively related to the probability of visitors' sensitivity to intensive use, while the number of visitors who preferred pathway 21 is negatively related to the probability of visitors' preferences to intensive use (Equation 5.5).

Table 5.6 The probability of visitor density preferences using Logistic Regression Analysis.

Dependent Variable	*B* (co-efficient)	Independent Variable	Signif.	Overall (% classified correctly from sample-derived prior probability)	χ^2 Sig.	Contrast Method
Crowd	-2.1218	*P12(1)*	.0631	73.4%	0.0325*	Indicator
	-1.0030	*P2(1)*	.0041			
	2.8012	*P21(1)*	.0077			
	-3.3103	*P22(1)*	.0451			
	-1.3334	*P23(1)*	.0188			
		Crowdview				
	-7.9911	*Crowdview(1) - Red Mansion*	.5324			
	-7.4424	*Crowdview(2) - Campsites*	.5608			
	-9.3099	*Crowdview(3) - Gingko Plantation*	.4680			
	-7.9858	*Crowdview(4) - The great spiritual tree*	.5322			
	-8.0941	*Crowdview(5) - University Pond*	.5265			
	-6.9124	*Crowdview(6) - the others*	.5891			
	12.4171	*Constant*	.3359			

where (*: significant)

Crowd: visitors' perception to the intensive use in Chitou (in term of 'Crowd Density')
P12(1), P2(1), P21(1), P22(1), P23(1): the number of visitors who preferred pathway 12, 2, 21, 22, 23
Crowdview: the number of visitors who felt the people density too high at the viewpoints

The Logistic Regression Model for visitor Crowd Intensity occurrence by examining visitors' perception to the intensive use in Chitou (*Crowd*) is presented as-

$$\textbf{PROBABILITY OF VISITOR DENSITY OCCURRENCE} = \frac{1}{1+e^{-Z}} \qquad \textbf{Equation 5.5}$$

Where $Z = 12.4171 - 2.1218\,P12(1) - 1.0030\,P2(1) + 2.8012\,P21(1) - 3.3103\,P22(1) - 1.3334\,P23(1) - 7.9911\,Crowdview(1) - 7.4424\,Crowdview(2) - 9.3099\,Crowdview(3) - 7.9858\,Crowdview(4) - 8.0941\,Crowdview(5) - 6.9124\,Crowdview(6)$

5.5 Factor Analysis (FA)

5.5.1 FA Satisfaction preference model approach: (Appendix A)

A. FA Method Selection and Data Preparation

With a view to increasing the R^2 value, Factor Analysis was attempted as a preliminary working of the data. In addition, there are many variables, 53 and 77 variables, in the 'Satisfaction' and 'Crowd Intensity' Questionnaires, respectively (Appendix A and B). Simplifying and integrating these variables permitted further LR for comparison with previously analysis (Section 5.3, 5.4 and 5.5) (Norušis, 1993a). The *Principal components method* was used for factor extraction and all factors produced by this way whose *eigenvalues* exceeded 1 (Rummel, 1970, p353-363; SPSS default setting) were extracted and the components with eigenvalues below the cut-off were not retained in the solution. As Norušis (1993a) mentioned the most commonly used method is the varimax method, which attempts to minimise the number of variables that have high loadings on a factor. This should enhance the interpretability of the factors.

Varimax, an orthogonal rotation, was the factor transforming method specified here. The purpose of rotation is to make the result of FA more interpretable which won't affect the result of factor analysis (Norušis, 1993a, p50-65).

Factor scores for each case of factor variables were produced and used as variables instead of using original data as independent variables in Linear Regression Analyses to represent the values of the factors. The regression factor scores have a variance equal to the squared multiple correlation between the estimated factor scores and the true factor values (Norušis, 1993b, p73).

Norušis stated that factor scores created by the regression method can be correlated even when factors are assumed to be orthogonal. Dependent variables including both visitor satisfaction perception and Willingness To Pay (WTP) for half of current visitor density were standardised as coefficients, respectively and used as dependent variables in both model approaches. This is in account of having all coefficients as processing variables for standardisation reason instead of original dependent or independent variables (factor scores were conducted as independent variables instead of original variables).

B. Factor Analysis Result for 'Satisfaction':

52 independent variables were grouped into 17 factors (Factor1 to Factor17) (Table 5.7). Each group was given a factor name (Theme) to characterise the grouped variables. Factor loadings were sorted in order and grouped to indicate the weight of each variable which contributed to the factors. If the factor loadings were too small, they were ignored at this stage because they can indicate a lower weight assigned to each factor.

Factor scores for each of the 17 factor variables were produced and used instead of the original data for subsequent LR. In factor pattern matrices (Table 5.7), 17 factors are displayed and structured and factor loadings are sorted so that variables with high loadings on the same factor appear together.

Table 5.7 Factor pattern matrix using Factor Analysis for the study of visitor satisfaction perception and the structure of the extracted factors

Factor Name (Theme)	Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10	Factor 11	Factor 12	Factor 13	Factor 14	Factor 15	Factor 16	Factor 17
1. Colour	Orange	0.83369	-0.00608	0.11906	0.0638	-0.11353	0.0591	0.02543	-0.08267	0.0924	0.01691	-0.10032	-0.03532	0.03167	-0.04106	-0.06186	-0.06537	-0.03781
	Yellow	0.80873	0.05259	0.06933	0.04283	-0.04282	-0.02142	0.02644	0.00149	0.05503	0.08782	0.02668	-0.05165	0.08414	-0.11415	-0.1206	-0.06144	0.04739
	Red	0.76799	0.00488	-0.07706	0.12673	-0.03741	-0.06012	-0.03299	0.03173	0.14929	-0.08146	-0.14618	-0.05555	0.01256	-0.04024	-0.00505	-0.08029	-0.09845
	Brown	0.74425	-0.04895	-0.12889	-0.09376	0.03257	0.13085	0.01882	-0.04858	0.0083	0.08503	0.09036	-0.00095	-0.13196	0.03192	0.09329	0.08714	-0.00211
	Light Green	0.63082	0.03692	0.04699	0.06909	0.29546	-0.02788	-0.0686	-0.07462	-0.02892	0.04784	-0.08731	0.09095	0.01113	0.36143	-0.01381	0.11538	0.11164
	Light	0.56337	-0.03162	0.02354	-0.05662	0.20297	0.08262	0.05257	0.23433	-0.16471	-0.0133	0.03603	0.20407	-0.05541	-0.15012	0.0037	0.12059	-0.4058
	Dark Green	0.55956	0.07395	0.08356	-0.13691	0.27952	0.03564	-0.11964	0.24531	-0.02001	0.16	-0.04643	0.04478	-0.03198	0.09847	0.02666	0.0137	0.24166
2. Transportation	Tranfee	0.05958	0.89629	0.21003	-0.00508	-0.00349	0.00015	0.0159	0.05559	-0.0181	-0.02347	0.05233	-0.04427	0.05254	0.04908	-0.06346	0.07909	-0.07416
	Trantime	-0.06783	0.78409	0.00273	-0.01384	0.02837	0.01765	0.09163	0.05989	-0.00614	0.05465	0.15198	-0.03348	-0.03199	-0.07071	0.15359	-0.12517	0.06027
	Hour	0.015	0.52425	0.08348	-0.17376	0.18402	-0.01276	-0.03344	0.16707	0.03886	0.16943	-0.23754	0.00564	-0.14794	-0.08929	0.12821	0.05218	0.2757
	Visit Times	-0.02589	-0.36373	0.32838	0.05286	0.04756	-0.01153	0.02098	-0.03285	0.04716	0.01383	0.17874	-0.36291	-0.29463	0.00439	-0.06593	0.29129	-0.04832
3. Visitor Background	Age	-0.04413	0.15051	0.80276	-0.06967	0.12271	-0.03377	-0.12943	0.12547	0.09961	0.03665	0.05128	-0.15993	-0.02397	0.17221	0.00402	-0.00524	-0.01854
	Income	0.04816	0.05349	0.7435	-0.00955	-0.02238	-0.07012	0.08974	0.1026	0.08555	0.07388	-0.09849	-0.10169	0.09809	0.2063	0.08992	-0.13472	0.00345
	Education	0.07692	0.17716	0.70114	0.01463	-0.09507	-0.0946	-0.07461	-0.03758	-0.07401	-0.01094	0.12344	0.13894	-0.00314	-0.13886	0.0191	0.06465	0.0779
	Ticket	-0.01969	0.09857	0.6547	-0.06648	0.00268	0.04319	-0.40903	-0.06208	0.11421	-0.03526	0.05699	0.16671	-0.08402	-0.05377	0.05388	0.10694	0.00603
4. Man-made Forest	Forest2	-0.01009	0.0288	0.01103	0.84982	0.13883	0.06346	-0.00202	0.03429	0.02498	0.02601	-0.0123	0.06005	0.00658	-0.12442	-0.04707	-0.03245	0.02668
	Forest3	0.08574	-0.06947	-0.15731	0.79306	-0.00909	0.20194	-0.07793	0.06248	0.05414	0.09118	0.00563	0.0539	-0.05772	0.07169	-0.00433	-0.02078	-0.05199
	Forest1	0.01208	-0.05333	0.04382	0.76962	0.02156	0.23438	0.04411	0.04214	0.06854	0.04319	-0.00169	-0.03429	-0.00205	0.06332	0.06885	-0.00799	0.1358
5. Simple Landscape	Landscape1	0.03127	-0.01411	0.00533	0.0204	0.7834	0.1579	0.07744	-0.0992	0.07388	0.04188	-0.11635	-0.07997	0.2251	-0.05018	-0.14251	0.01097	-0.03023
	Mixed Forest	0.01454	-0.07338	-0.06271	0.11653	0.66358	-0.00917	0.07203	0.01164	0.29437	-0.11569	0.02613	0.04372	-0.22283	-0.09822	-0.00376	-0.0757	-0.06491
	Landscape2	0.1559	0.26812	0.06329	0.08313	0.55259	0.01166	-0.01431	-0.00456	0.25818	-0.10496	0.0676	-0.02617	-0.09711	0.26829	-0.04733	0.04582	0.0596
6. Natural Forest	Forest5	-0.00924	-0.05531	0.02684	0.18142	0.11952	0.82555	-0.04853	-0.0736	-0.05924	-0.0068	-0.07057	0.04105	0.02301	-0.01169	0.00364	0.02946	-0.03148
	Forest4	0.05403	-0.02123	-0.07682	0.2885	0.0127	0.73415	0.03579	0.05024	0.04041	-0.11058	0.08336	0.03624	-0.19862	0.09558	0.03877	-0.0928	0.10058
	Forest6	0.13079	0.11609	-0.16322	0.13266	0.00278	0.60279	-0.00817	-0.05325	-0.10197	0.18037	-0.1226	0.05429	0.1753	-0.04558	-0.17553	0.06572	-0.06841
7. Background	Children	-0.06343	-0.00004	-0.26668	-0.00372	0.07309	-0.00568	0.84244	0.00912	-0.05295	0.12937	0.06869	0.0702	-0.00432	0.05545	0.00141	-0.04795	0.03776
	Total	0.01872	0.16624	-0.06253	-0.01371	0.06902	-0.04253	0.81145	-0.02647	-0.11188	0.13438	0.15987	0.0883	-0.00866	0.0811	0.07828	-0.04294	0.06304
	Sex	0.02413	-0.10341	0.23402	-0.11052	-0.18513	0.12624	0.45752	0.09226	0.00201	-0.00522	-0.23654	-0.37816	0.27583	-0.12723	-0.03844	0.16095	-0.01746

8. Entrance Fee	Wtpviewyes	0.02432	-0.09501	-0.03673	-0.11853	0.12593	0.0709	-0.06719	-0.81958	-0.0317	-0.02955	-0.05862	0.06595	0.04077	0.00897	0.02164	-0.04346	-0.0004
	Wtpview	0.05487	0.10818	0.10418	0.05529	0.06609	-0.03095	-0.0738	0.80724	-0.02413	0.08285	-0.00285	0.00008	0.11444	-0.05259	-0.14792	-0.02191	0.13082
9. Complex	Landscape3	0.13079	0.00285	0.13914	0.11452	0.13345	-0.06696	-0.07184	-0.08192	0.81215	0.05445	0.06198	-0.04068	0.05127	-0.0089	0.01199	0.04031	-0.0446
Landscape	Landscape4	0.09729	-0.03738	-0.04556	0.02826	0.19299	-0.02971	-0.08811	0.14874	0.73474	-0.17269	-0.07874	-0.01707	-0.17979	0.03853	-0.04903	0.10659	0.01377
	Pure Forest	-0.0277	0.06634	0.23528	0.01087	0.25099	0.01538	-0.11282	-0.02645	0.49863	0.27122	0.24721	-0.00816	0.30292	0.08012	-0.07422	-0.12598	-0.08219
10. Plantation	PathplantD	0.10757	0.01814	-0.01957	0.07062	-0.03463	0.0249	0.06959	0.03579	0.00354	0.88142	-0.03384	0.0292	-0.01308	-0.00724	-0.0602	0.03712	-0.00175
Arrangement	PathplantL	-0.06323	-0.01023	-0.073	-0.0678	0.04594	0.00699	-0.16949	-0.09251	0.03997	-0.83837	0.0245	0.01801	0.09894	0.04325	-0.0333	-0.01442	0.03759
Along Paths																		
11. Facility	Facenough	0.09579	-0.04146	-0.05571	-0.10889	0.14783	0.07084	-0.02346	-0.09023	-0.12498	-0.04555	-0.75193	0.15347	-0.046	0.10754	-0.1138	-0.0387	0.04994
Amount	Facility	-0.06355	0.07784	0.05882	-0.10649	0.06108	-0.01805	0.12751	0.00277	-0.0417	-0.09859	0.74043	0.03351	0.11455	-0.03861	-0.06776	0.00752	0.03383
12. Visit Choice1	When	0.00401	-0.08946	-0.02072	0.06145	-0.02992	0.09366	0.05731	0.01508	0.00433	-0.00768	-0.04101	0.66546	-0.01965	0.1027	0.01784	0.13905	0.08431
	Visitorder	-0.00366	-0.14288	0.07728	0.04853	0.00734	0.00104	0.06479	-0.16899	-0.12979	0.13711	-0.13351	0.52101	0.20776	-0.41522	0.07266	-0.05703	0.05208
13. Landscape	Viewlike	0.0245	0.04315	-0.0055	-0.03522	0.03177	0.04853	0.04869	0.01033	-0.06761	-0.03215	0.07889	-0.09273	0.68719	-0.01205	0.16632	0.0714	0.15995
Impression	Reason	-0.06666	-0.08111	-0.14681	0.09828	0.07071	-0.12245	-0.07648	0.1821	-0.08565	-0.14536	0.15171	0.18947	0.46407	0.19597	0.08356	0.29388	-0.14847
	Impression	-0.05932	0.01422	0.10705	-0.10439	-0.26829	-0.09603	0.05383	-0.02078	0.24223	-0.13138	0.15588	0.30182	0.46358	-0.06154	0.00405	0.01368	0.07315
14. Enjoyment	Length	-0.04064	0.01701	-0.18662	-0.11109	0.06521	0.0901	-0.20319	0.14238	0.03804	-0.01164	0.07202	-0.13815	-0.0485	-0.68312	0.07367	0.06172	0.20176
	Colourcha	-0.17612	-0.03373	0.0468	-0.1927	0.08007	0.26111	-0.02966	-0.00246	0.09218	-0.06788	-0.22744	-0.15748	0.02714	0.57135	0.20705	-0.04309	0.1518
15. Facility/	Enough	0.03817	-0.02686	0.04596	-0.08607	-0.17846	-0.11534	0.10653	0.00592	0.09042	-0.00055	-0.04989	-0.00289	0.1371	0.10864	0.7532	0.04334	-0.03704
Amenity	Enoughin	-0.11769	0.08179	0.05716	0.12515	0.04353	0.03799	-0.06278	-0.27516	-0.19113	0.00198	0.18804	0.02685	0.15592	-0.06317	0.62517	-0.01915	0.04934
Amount	Facreason	0.10847	-0.07787	-0.12268	-0.07061	0.02431	-0.02253	0.01626	0.07198	0.10052	0.12652	0.21628	-0.38795	0.1488	0.21129	-0.46313	0.07614	0.26811
16. Visit Choice2	Duration	0.01232	0.21816	-0.11828	-0.17883	-0.03753	0.11509	-0.0641	0.05231	0.02904	0.082	-0.00885	-0.06455	0.09048	-0.22131	0.15218	0.64648	0.15
	Choice	-0.06762	-0.01128	0.07153	-0.02655	-0.02549	-0.00396	0.01292	0.09189	0.20108	0.07618	0.12362	0.25999	0.13037	0.05412	-0.15649	0.57806	-0.16981
	Price	0.05037	-0.12847	0.11954	0.15327	0.02606	-0.15882	-0.06989	-0.41587	-0.10853	-0.10788	-0.13719	0.01173	-0.00092	0.12151	0.01886	0.52532	0.07684
17. Conservation	Wtpconserve	-0.02355	0.01088	0.07547	0.18579	-0.0127	-0.01374	0.11611	0.16763	-0.09862	-0.07896	-0.01668	0.15052	0.19022	-0.08355	-0.04224	-0.00149	0.66229
Value	Again	0.09336	-0.0467	-0.05904	-0.15916	-0.25752	0.2419	0.02746	-0.13061	-0.01321	0.01298	0.06065	0.30426	-0.06084	-0.14069	-0.15846	0.21698	0.33308
	Eigenvalue	4.36666	3.95985	3.03475	2.88278	2.42588	2.22194	2.07719	2.04162	1.73777	1.66883	1.55097	1.33511	1.3105	1.18954	1.16787	1.13401	1.04652
	Pct of Var	8.4	7.6	5.8	5.5	4.7	4.3	4	3.9	3.3	3.2	3	2.6	2.5	2.3	2.2	2.2	2
	Overall																	**67.6%**

As Table 5.7 shows, the 17 factor scores were classified and represented 67.6 percent of visitors' characteristics. The procedure of LR model approach by this way displays in Figure 5.1.

Figure 5.1 The procedures of RPMs approach by Factor Analysis.

The LR model obtained using these independent factors and factor scores is shown in Equation 5.6 with a R^2 of 52.49 percent. The F value is highly significant (<0.001). The 17 independent variables for predicting visitor satisfaction to the Park (including *the preferences to the plantation arrangement along paths, visit time and places, the amount of amenity areas* and *facilities, transportation fee and time, visitor background* such as age, income, education and ticket and *the preferences to man-made forest, simple landscape and natural forest*) with the relative importance from high to low have a positive effect to the visitor satisfaction. The other independent variables (including *the preferences to facility amount and types, recreation enjoyment* (in terms of *staying duration* and *colour preferences*), *landscape preferences, potential visit duration* and its considering factors, *conservation value, colour preferences, visitor background (children numbers, total numbers and sex)* and *willingness to pay for more views* and *complex landscape structure)* with the importance from high to low have negative relationship with visitors' satisfaction perception.

zsatisfy = 0.015593Factor10 -0.23315Factor11 +0.370322Factor12 -0.14816Factor13 -0.15495Factor14 + 0.353905Factor15 -0.07339Factor16 -0.19701Factor17 -0.20462Factor1 +0.052349Factor2 + 0.103194Factor3 + 0.096699Factor4 +0.062278Factor5 +0.053471Factor6 -0.03481Factor7 - 0.12648Factor8 -0.17073Factor9 **Equation 5.6**

(Multiple R = .72446 , R^2 = .52485 and significant F< 0.001)

Where

zsatisfy: Visitor satisfaction to the park or not (standardised)

Factor 1: Colour preferences

Factor 2: Transportation fee and time

Factor 3: Visitor Background 1

Factor 4: Man-made Forest

Factor 5: Simple Landscape

Factor 6: Natural Forest

Factor 7: Visitor Background 2

Factor 8: Entrance Fee

Factor 9: Complex Landscape

Factor 10: Plantation Arrangement Along Paths

Factor 11: Facility amount and types

Factor 12: Visitor Choice 1- When and where to visit

Factor 13: Landscape preferences

Factor 14: Enjoyment-visit duration and the preference to colour changing

Factor 15: Facility / Amenity Amount

Factor 16: Visitor Choice 2- duration and considering factors

Factor 17: Conservation Value

5.5.2. FA Visitor Density Preference Model Approach: (Appendix B)

All 76 independent variables were grouped into 23 factors (Factor1 to Factor23) using factor analysis except the variable stands for willingness to pay for half of current visitor density (Table 5.8). Each new representative FACTOR was given a FACTOR NAME (Theme) to characterise the variables in each group. As shown in the factor pattern matrix in Table 5.8, the factor loadings were sorted in order and grouped to indicate the weight of each variable which contributed to the factors. The small factor loadings were ignored due to their limited contribution.

Table 5.8 Factor pattern matrix using factor analysis for visitor density exploration and the structure of the extracted factors

Factor Name (Theme)	Variables	Fac 1	Fac 2	Fac 3	Fac 4	Fac 5	Fac 6	Fac 7	Fac 8	Fac 9	Fac 10	Fac 11	Fac 12	Fac 13	Fac 14	Fac 15	Fac 16	Fac 17	Fac 18	Fac 19	Fac 20	Fac 21	Fac 22	Fac 23
1. Path Visited	Section 18	0.934	0.002	0.071	-0.035	0.005	-0.029	0.015	-0.006	-0.057	0.037	-0.084	-0.093	0.005	-0.049	-0.084	0.070	0.016	-0.011	-0.006	0.050	-0.011	-0.013	-0.008
	Section 8	0.925	-0.020	0.081	-0.010	-0.056	-0.019	-0.006	-0.034	-0.023	0.012	-0.009	0.063	-0.060	-0.025	0.056	-0.082	0.033	-0.022	-0.011	-0.003	-0.017	0.006	0.032
	Section 9	0.920	-0.010	0.077	-0.072	0.030	0.013	0.010	-0.004	-0.022	0.031	-0.073	-0.081	0.084	-0.030	-0.003	0.015	0.029	0.026	0.021	0.016	-0.026	0.019	0.029
	Section 16	0.913	-0.028	0.070	0.069	-0.029	-0.061	0.007	-0.014	0.002	0.051	-0.055	-0.032	0.053	-0.003	-0.105	0.091	-0.084	0.031	0.039	0.019	0.053	-0.052	-0.083
	Section 17	0.905	-0.004	0.015	0.100	-0.012	-0.081	0.027	0.018	0.056	0.072	-0.088	-0.051	0.013	-0.041	-0.102	0.054	-0.050	0.007	-0.008	0.043	0.022	-0.054	-0.037
	Section 15	0.886	-0.021	0.070	0.073	-0.025	-0.068	-0.019	-0.026	0.001	0.046	-0.054	-0.041	0.035	0.037	-0.086	0.108	-0.075	0.020	0.029	0.009	0.050	-0.070	-0.110
	Section 7	0.874	-0.023	0.054	-0.023	-0.024	0.001	0.005	-0.046	-0.013	-0.033	-0.021	0.128	-0.088	0.059	0.108	-0.098	0.041	-0.017	-0.049	-0.041	-0.019	0.031	0.003
	Section 14	0.857	-0.064	-0.035	0.181	-0.065	-0.043	-0.043	0.069	0.168	-0.042	0.081	0.149	0.006	-0.002	0.121	-0.035	0.096	-0.020	0.001	-0.140	0.014	0.055	0.046
	Section 13	0.814	-0.086	-0.036	0.172	-0.082	0.026	-0.089	0.091	0.186	-0.050	0.077	0.130	0.048	0.033	0.129	-0.078	0.108	0.012	0.013	-0.151	0.027	0.042	0.047
	Section 19	0.776	0.034	0.237	-0.091	0.060	0.042	0.045	0.039	-0.117	0.037	-0.004	-0.097	0.071	-0.166	-0.027	0.170	-0.060	-0.001	-0.055	0.096	0.063	0.015	-0.013
	Section 12	0.739	-0.085	-0.026	-0.025	-0.089	0.030	-0.084	0.035	0.130	-0.048	0.139	0.037	0.326	0.033	0.100	-0.126	0.209	0.068	-0.041	-0.071	-0.046	-0.012	0.028
	Section 22	0.718	0.011	0.359	-0.077	0.044	0.049	0.025	-0.043	-0.015	0.169	-0.066	-0.126	0.010	0.040	0.004	0.034	-0.024	-0.062	-0.081	0.134	-0.042	0.011	0.088
	Section 10	0.649	0.072	0.096	-0.026	0.013	-0.088	0.031	-0.015	-0.049	-0.057	0.043	-0.131	0.015	-0.069	0.049	-0.084	-0.156	0.039	0.383	-0.004	0.052	0.210	0.163
	Section 4	0.626	0.079	-0.026	-0.125	0.134	0.004	0.085	-0.169	-0.076	0.010	0.166	-0.169	-0.049	0.035	0.067	-0.143	-0.157	-0.147	0.149	0.220	-0.007	-0.003	0.024
	Section 5	0.590	-0.055	-0.107	-0.034	-0.052	-0.055	-0.056	-0.022	-0.214	-0.074	0.074	0.074	-0.118	0.034	-0.156	0.220	0.053	-0.030	-0.177	-0.038	0.292	-0.033	0.046
	Section 11	0.569	0.191	-0.212	0.057	0.056	-0.098	-0.067	0.042	-0.200	-0.015	0.272	0.022	-0.211	0.014	-0.103	0.190	-0.162	0.104	-0.184	0.007	0.187	-0.091	0.094
	Section 6	0.546	0.174	0.005	-0.041	0.035	0.059	0.035	-0.238	0.032	0.017	0.009	-0.038	-0.047	0.374	-0.007	-0.098	-0.189	-0.222	-0.035	0.146	-0.037	-0.072	-0.146
	Section 23	0.521	-0.035	0.103	-0.092	-0.187	-0.091	-0.003	-0.088	0.121	-0.069	0.248	-0.051	0.478	-0.061	-0.083	0.146	-0.123	-0.022	-0.012	-0.067	0.041	0.052	-0.134
2. Path Preferred	P16	-0.065	0.875	0.127	0.184	0.016	0.001	0.020	0.002	-0.016	-0.027	-0.029	0.192	0.052	0.069	-0.053	0.003	0.095	-0.018	0.097	-0.002	-0.015	-0.020	-0.030
	P18	-0.044	0.810	-0.129	0.070	0.028	-0.012	0.076	-0.059	0.018	-0.032	-0.022	-0.005	0.034	0.101	0.028	0.006	-0.122	0.100	0.013	0.028	0.027	0.040	0.044
	P9	-0.032	0.789	-0.129	0.041	-0.013	0.120	0.052	0.157	0.008	0.023	-0.007	-0.024	0.016	0.057	0.112	0.000	-0.097	0.088	0.171	-0.010	-0.007	0.010	0.076
	P17	-0.014	0.773	-0.176	0.154	0.089	-0.020	0.068	0.054	0.190	-0.006	-0.008	-0.006	0.087	-0.063	0.125	-0.054	0.103	-0.031	-0.001	0.005	0.047	0.068	-0.011
	P22	-0.089	0.770	0.225	0.066	-0.028	-0.040	-0.026	0.133	-0.024	0.072	-0.049	0.138	-0.035	-0.005	-0.075	-0.143	0.125	0.040	-0.066	0.025	-0.035	-0.091	-0.077
	P8	0.011	0.720	0.130	0.137	0.041	0.088	-0.066	-0.070	-0.008	-0.111	-0.033	0.126	0.017	0.013	-0.116	0.046	0.067	-0.068	0.130	-0.060	-0.024	-0.109	0.001
	P19	0.265	0.602	-0.024	-0.086	0.024	0.187	0.056	0.016	0.117	0.071	-0.079	-0.014	0.174	-0.161	-0.013	0.098	-0.197	-0.047	-0.097	-0.035	0.188	0.078	-0.030
	P7	-0.002	0.575	0.104	0.057	-0.097	-0.154	0.029	0.054	-0.019	-0.160	0.179	0.122	-0.011	0.058	0.014	0.226	0.203	-0.133	0.061	-0.075	0.031	-0.038	-0.081
	P20	0.205	0.467	0.209	-0.130	0.074	0.060	0.057	-0.033	0.085	0.184	0.169	-0.046	-0.072	-0.270	0.045	-0.088	-0.127	0.071	-0.190	-0.109	0.062	0.248	-0.098
	P21	0.032	0.427	0.335	-0.082	0.091	0.153	-0.080	0.243	0.034	0.227	-0.178	0.165	0.149	-0.022	-0.151	-0.246	-0.051	-0.123	-0.096	-0.064	0.060	-0.114	-0.072
	P1	-0.142	0.377	-0.078	0.004	-0.156	0.000	-0.032	0.182	0.114	-0.133	0.071	0.336	-0.008	-0.312	-0.052	-0.054	0.289	0.019	-0.149	0.306	-0.124	-0.016	-0.038
3. Path Visited	Section 21	0.265	0.014	0.755	-0.079	0.080	-0.071	0.019	0.111	0.158	0.005	-0.007	-0.068	0.035	0.027	-0.097	0.122	-0.164	0.005	-0.063	-0.035	-0.090	0.091	0.121
	Section 20	0.470	0.046	0.659	-0.071	0.012	-0.084	-0.008	0.086	0.024	0.009	0.077	-0.091	-0.006	-0.175	-0.021	0.147	-0.026	0.103	-0.012	-0.062	0.105	0.094	0.003
	Section 3	0.472	0.036	0.606	0.000	-0.035	-0.078	0.037	-0.022	0.161	-0.020	-0.211	-0.063	-0.103	0.043	-0.005	-0.048	-0.001	-0.002	0.055	0.079	0.025	-0.032	-0.111
	P3	-0.066	0.326	0.400	0.000	-0.240	0.099	0.071	-0.031	-0.094	-0.117	0.156	0.050	-0.230	0.004	0.153	-0.257	0.187	-0.042	-0.182	0.107	0.102	-0.110	-0.079

4. Path Preferred	P14	0.089	0.220	-0.033	0.873	0.021	-0.064	-0.006	0.006	0.005	0.056	0.088	0.021	-0.011	-0.036	0.026	-0.071	-0.005	-0.020	-0.063	0.010	-0.047	0.072	-0.055
	P13	0.001	0.202	-0.098	0.815	0.015	0.027	-0.023	0.032	0.093	-0.043	0.058	0.008	-0.079	-0.111	0.066	-0.047	0.023	0.049	-0.050	-0.011	0.061	-0.066	-0.033
	P15	-0.012	0.470	0.086	0.524	-0.124	-0.046	0.002	-0.059	0.040	0.096	0.000	0.092	-0.006	0.195	-0.110	0.176	-0.176	0.043	0.023	0.020	0.085	-0.013	-0.062
5. Income	INCOME	0.003	0.043	-0.031	-0.006	0.751	0.079	0.118	0.087	-0.021	-0.011	0.073	0.079	-0.080	-0.007	-0.027	-0.068	0.023	0.151	-0.013	-0.012	-0.017	-0.010	-0.144
	AGE	-0.148	-0.021	0.085	0.033	0.714	-0.018	-0.046	-0.047	-0.126	0.004	-0.013	0.107	-0.016	-0.062	0.208	0.186	0.035	-0.133	0.142	0.081	0.094	-0.005	0.059
	SEX	-0.036	0.203	0.102	-0.273	0.336	0.153	-0.177	0.136	-0.177	-0.141	-0.051	-0.166	-0.021	-0.144	-0.189	0.113	0.144	0.242	-0.138	-0.020	0.119	0.018	-0.153
6. Less Visitor Density	DECRSE22	-0.107	0.103	-0.029	-0.070	0.057	0.867	0.087	0.061	-0.002	-0.023	0.041	0.012	0.015	-0.064	0.003	0.063	-0.036	0.042	0.002	-0.008	0.001	0.170	0.004
	DECREASE	0.117	-0.028	0.062	-0.011	-0.005	-0.859	-0.062	-0.010	0.059	0.007	0.014	0.033	-0.020	0.004	-0.097	0.105	0.008	0.015	-0.033	0.036	-0.083	0.048	-0.075
7. Visitor Amount	CHILDREN	0.007	-0.075	0.048	-0.005	-0.004	0.112	0.884	-0.041	-0.080	-0.075	-0.060	0.005	-0.018	-0.013	-0.031	0.056	0.016	0.026	0.034	-0.046	0.032	-0.040	0.017
	TOTAL2	-0.056	0.206	0.003	0.000	0.089	0.037	0.877	0.089	-0.056	0.017	-0.044	-0.019	0.012	0.046	0.006	0.020	-0.007	0.047	-0.027	-0.035	-0.034	-0.027	0.023
8. Transportation	TRANTIME	-0.002	0.175	0.030	0.028	-0.023	0.110	0.018	0.822	0.014	0.129	0.066	-0.049	0.026	0.016	-0.056	-0.002	-0.062	0.026	-0.016	-0.003	-0.021	-0.078	0.030
	TRANSFEE	-0.060	-0.009	0.132	0.006	0.173	-0.027	0.034	0.768	-0.048	-0.033	0.024	0.187	0.033	-0.002	-0.028	0.006	0.005	-0.126	0.021	0.287	0.089	0.063	0.064
	TIME3	0.085	-0.086	0.097	0.083	0.291	0.133	-0.026	-0.440	-0.003	-0.032	0.063	0.060	0.196	0.217	-0.059	-0.009	0.186	-0.004	0.104	0.254	0.276	0.187	0.108
9. Visitors Around	VISITORS	0.052	-0.085	-0.057	-0.043	0.077	0.046	0.144	0.035	-0.684	-0.013	0.056	0.104	-0.089	-0.061	-0.145	-0.089	0.129	0.007	0.133	-0.070	0.093	-0.051	0.114
	SIGNPOST	0.116	0.139	0.151	0.124	-0.029	0.051	0.075	-0.090	0.606	0.142	0.028	0.052	-0.068	-0.197	-0.217	0.014	0.077	-0.098	0.246	-0.052	0.063	-0.093	0.041
	PLACE	-0.042	0.067	0.144	0.054	-0.122	-0.109	-0.141	0.114	0.571	0.078	0.081	-0.094	0.053	0.158	0.033	0.045	-0.272	0.172	-0.170	-0.142	0.155	0.021	-0.057
	LIKE.1	0.041	0.128	-0.111	-0.078	0.317	-0.073	-0.045	0.056	0.359	-0.018	-0.018	-0.076	-0.187	0.232	-0.095	-0.015	0.347	0.294	0.057	-0.072	0.129	0.182	0.167
10. Blocks Needed	BLOC.1	0.053	0.021	0.098	-0.052	-0.121	0.117	-0.075	0.085	0.019	0.745	0.096	0.076	0.031	0.107	0.229	0.132	-0.058	0.048	0.056	-0.069	0.102	-0.141	0.026
New Paths	IMP.1	0.057	-0.093	-0.059	0.094	0.082	-0.146	-0.010	0.064	0.140	0.740	0.044	-0.002	-0.057	0.040	-0.156	0.006	0.089	0.137	-0.034	-0.071	0.074	-0.036	-0.060
	DURATION	0.193	0.024	-0.047	0.153	-0.242	0.088	-0.067	-0.039	-0.044	0.331	0.014	-0.131	0.247	-0.179	-0.172	0.025	0.021	-0.011	-0.235	0.217	0.064	0.208	0.282
11. Path Preferred	P2	-0.054	0.125	-0.055	-0.110	-0.102	-0.066	0.048	-0.036	-0.077	-0.131	-0.744	-0.067	-0.051	-0.038	0.129	-0.059	0.009	0.053	-0.095	-0.093	0.164	-0.103	0.014
	Section 2	0.212	-0.055	0.253	-0.072	0.067	0.041	0.093	-0.021	0.123	-0.052	-0.650	-0.001	-0.063	-0.016	-0.051	0.050	0.125	-0.295	0.090	0.146	-0.098	0.156	-0.076
	EDUCATION	0.140	0.112	0.131	0.128	0.027	-0.010	-0.114	0.207	0.058	-0.316	0.399	-0.108	0.086	0.100	-0.107	-0.204	-0.065	-0.093	0.100	-0.133	0.328	-0.027	-0.011
12. Path Preferred	P5	-0.040	0.224	-0.066	0.086	0.025	-0.035	0.049	0.030	-0.058	0.063	-0.014	0.761	0.005	0.143	-0.040	0.003	-0.077	0.048	-0.083	0.002	0.058	0.081	-0.102
	P11	-0.068	0.284	-0.066	-0.029	0.197	0.016	-0.062	0.047	-0.093	-0.002	0.069	0.726	-0.020	-0.106	0.022	0.074	-0.039	-0.001	-0.008	0.109	-0.131	-0.037	0.172
13. Path Preferred	P23	0.063	0.207	-0.047	-0.096	-0.088	0.066	-0.026	0.034	0.007	-0.007	0.036	0.010	0.812	0.071	0.037	-0.020	-0.038	0.087	-0.013	-0.087	0.100	-0.141	-0.091
	P12	-0.023	0.358	-0.130	0.341	0.281	-0.103	0.126	0.090	0.059	0.026	0.028	-0.024	0.415	-0.194	0.233	-0.133	0.096	-0.066	-0.117	0.052	-0.097	-0.012	0.123
14. Facility Location	FACILITY	-0.025	-0.011	-0.076	-0.071	-0.106	-0.099	0.053	0.014	0.019	0.063	0.142	0.061	0.057	0.645	-0.011	0.062	0.019	0.132	0.008	-0.143	0.108	0.032	-0.132
	P6	-0.092	0.313	0.069	-0.049	0.076	0.059	-0.058	-0.021	0.079	0.092	-0.170	-0.013	-0.066	0.548	-0.019	-0.035	0.052	-0.339	-0.176	0.144	-0.144	-0.008	0.077

15. Footpath	SATISFY	0.052	-0.026	-0.064	0.045	0.177	0.218	-0.011	-0.114	-0.018	0.020	-0.041	-0.020	-0.004	0.039	0.717	0.107	0.042	-0.023	0.006	0.090	0.014	-0.022	-0.145
Satisfaction	CROWD	-0.053	0.067	-0.029	0.079	-0.139	-0.225	-0.046	0.057	0.134	0.042	-0.220	-0.019	0.114	-0.179	0.491	0.252	0.159	0.092	-0.010	-0.073	-0.006	-0.150	-0.125
16. Maximum of	PEOPLE	0.114	0.006	0.117	-0.104	0.067	0.001	0.048	-0.014	0.131	0.082	0.014	0.070	-0.023	0.044	0.139	0.718	0.009	-0.054	-0.059	-0.024	-0.072	-0.002	0.109
Visitor Around	VIEW.1	0.003	0.094	-0.043	0.108	0.030	-0.153	0.094	0.069	-0.177	0.313	-0.054	-0.095	0.053	-0.011	0.211	0.426	0.024	-0.183	0.141	-0.004	-0.233	0.191	-0.210
17. Larger Visitor Density	INCREASE	-0.042	0.074	-0.090	-0.028	0.063	-0.047	0.012	-0.104	-0.173	0.059	-0.093	-0.096	-0.023	0.012	0.103	0.028	0.791	0.043	-0.024	-0.031	-0.036	-0.050	-0.013
18. Path Interest	RE.1	-0.003	0.070	0.025	0.014	0.041	0.022	0.111	-0.084	0.035	0.183	0.062	0.066	0.052	0.004	0.023	-0.110	0.051	0.722	0.127	0.090	-0.021	0.094	0.038
	P4	-0.002	0.288	-0.119	-0.188	-0.154	-0.111	0.339	0.083	-0.128	0.014	0.234	0.010	-0.105	-0.061	0.154	-0.101	0.038	-0.403	0.163	0.033	0.201	0.142	-0.015
	DLIKE.1	-0.161	-0.081	0.036	-0.060	0.074	-0.068	-0.291	0.147	-0.132	-0.054	0.153	-0.128	-0.020	0.000	0.217	0.063	0.053	0.328	0.126	0.016	-0.165	0.276	0.279
19. Path Preferred	P10	-0.032	0.201	-0.079	-0.104	0.092	0.047	0.002	-0.019	-0.058	0.005	0.051	-0.086	-0.034	-0.031	0.000	-0.018	-0.004	0.121	0.794	0.004	0.074	-0.067	-0.050
20. Path Type Dislike	PATHD	0.010	-0.048	0.001	0.000	0.087	-0.068	-0.087	0.128	-0.056	-0.117	-0.041	0.079	-0.099	-0.078	0.092	-0.067	-0.064	0.050	0.032	0.721	0.131	-0.089	-0.006
	Section1	0.307	-0.101	-0.009	0.025	-0.296	0.062	0.004	0.077	0.066	0.111	0.068	0.016	0.014	0.075	-0.097	0.204	0.095	0.074	-0.127	0.445	-0.107	-0.196	-0.255
21. Path Width	WIDTH	0.116	0.089	0.004	0.021	0.074	0.089	0.038	0.001	0.034	0.156	-0.069	-0.047	0.077	0.033	0.026	-0.102	-0.035	-0.026	0.074	0.110	0.777	0.039	0.002
22. Visitor Activities	ACT.1	-0.015	-0.041	0.072	0.006	-0.005	0.131	-0.069	-0.074	0.031	-0.118	-0.002	0.066	-0.113	0.029	-0.079	0.033	-0.043	0.089	-0.064	-0.128	0.042	0.822	-0.120
23. Path Type Like	PATHL	0.029	-0.063	0.023	-0.092	-0.091	0.088	0.051	0.057	-0.076	-0.026	0.017	0.035	-0.096	-0.086	-0.183	0.073	-0.001	0.053	-0.038	-0.052	0.010	-0.128	0.769
	Eigenvalue	12.396	6.958	3.109	2.853	2.501	2.341	2.269	2.156	1.923	1.893	1.839	1.669	1.590	1.457	1.340	1.295	1.263	1.173	1.113	1.100	1.095	1.008	1.002
	Pct of Var	16.300	9.200	4.100	3.800	3.300	3.100	3.000	2.800	2.500	2.500	2.400	2.200	2.100	1.900	1.800	1.700	1.700	1.500	1.500	1.400	1.400	1.300	1.300
	Overall																							72.8%

(*Fac 1- 23: Factor 1- 23)

The 23 factors were employed as independent variables for LR against the standardised dependent variable, willingness to pay for half of current visitor density. The factor scores of the 23 factors were adopted instead of the original data in LR.

The result of this factor extraction represented 72.8 percent of 214 visitors' characters. The procedures of the prediction model approach of visitor density preference using the Factor Analysis method are shown in Figure 5.1.

The best visitor density LR model (Equation 5.7) built with FA operation represents up to 77.3 percent of the visitors' characters. Independent variables including Factors 13, 15, 16, 18, 21, 2, 5, 6, 7 and 8, had a positive affect from high to low on visitors' Willingness to Pay for half of current visitor density. The other independent variables including Factors 10, 11, 12, 14, 17, 1, 20, 23, 3 and 9 had negative associations with visitors' Willingness to Pay for half of current visitor density.

zdecrease1 = -0.04628Factor10 - 0.01809 Factor11 - 0.02338 Factor12 + 0.053809 Factor13 - 0.0372 Factor14 + 0.018831 Factor15 + 0.023272 Factor16 - 0.0533 Factor17 + 0.024209 Factor18 + 0.050017 Factor19 - 0.09488 Factor1 - 2.56E-04 Factor20 + 0.051004 Factor21 + 0.061833 Factor22 - 0.01977 Factor23 + 0.021713 Factor2 - 0.01172 Factor3 - 0.10456 Factor4 + 0.048643 Factor5 + 0.850279 Factor6 + 0.076293 Factor7 + 0.021884 Factor8 - 0.01119 Factor9 **Equation 5.7**

(Multiple R = .87934, R^2 = .773 and significant $F < 0.001$)

Where

zdecrease1: standardised willingness to pay for half of current visitor density

Factor 1: Path Visited 1	Factor 13: Path Preferred 4
Factor 2: path Preferred 1	Factor 14: Facility Location
Factor 3: Path Visited 2	Factor 15: Footpath Satisfaction
Factor 4: Path Visited 3	Factor 16: Maximum of Visitor Around
Factor 5: Income	Factor 17: Larger Visitor Density
Factor 6: Less Visitor Density	Factor 18: Path Interest
Factor 7: Visitor Amount	Factor 19: Path Preferred 5
Factor 8: Transportation	Factor 20: Path Type Dislike
Factor 9: Visitors Around	Factor 21: Path Width
Factor 10: Blocks Needed New Paths	Factor 22: Visitor Activities
Factor 11: Path Preferred 2	Factor 23: Path Type Like
Factor 12: Path Preferred 3	

5.6 The Best Model for the Prediction of Recreation Perception

5.6.1 Recreation Perception Models. I- Satisfaction Preference Model

For prediction of visitors' satisfaction preference, Equation 5.3 is chosen as the best model.

$$\textbf{PROBABILITY OF SATISFACTION } (\textit{satisfy}) \textbf{ OCCURRENCE} = \frac{1}{1+e^{-Z}} \qquad \textbf{Equation 5.3}$$

Where $Z = 0.1965 + 1.1283\ BROWN\_Y + 0.6062\ FOREST5\_Y - 0.7708\ LANDSCAPE4\_Y - 1.5427\ ORANGE\_Y - 0.9182\ PURE\ FOREST\_Y$

The independent variables for predicting the probability of visitors' satisfaction to Chitou were selected on the basis of their combined Chi-Square scores (0.0424) and classification results (62.7 percent correct). These are the landscape components including the preferences for a high proportion of brownness in the scenery, for a high proportion of natural forest in the scenery, for a high proportion of complex landscape structure in the scenery, for a high proportion of orangeness in the scenery and for a high proportion of pure forest in the scenery. The high proportion of brownness and natural forest in the scenery have a negative influence on visitor enjoyment while the high proportion of complex but regular landscape structure, pure forest and orangeness in the scenery have a positive effect on visitors' satisfaction perception. This satisfaction model estimates the probability of satisfaction occurrence and accounts for 62.7 percent of visitors' preferences in Chitou. This is a satisfactory result considering the complexity of social science and volatility of visitor perception.

5.6.2 Recreation Perception Models. II- The Prediction Model for Visitor Density Preferences

For the prediction model of visitor density preferences occurrence, the best model was built from Equation 5.5.

PROBABILITY OF VISITOR DENSITY (*Crowd*) OCCURRENCE = $\frac{1}{1+e^{-Z}}$ **Equation 5.5**

Where $Z = 12.4171 - 2.1218\,P12(1) - 1.0030\,P2(1) + 2.8012\,P21(1) - 3.3103\,P22(1) - 1.3334\,P23(1) - 7.9911\,Crowdview(1) - 7.4424\,Crowdview(2) - 9.3099\,Crowdview(3) - 7.9858\,Crowdview(4) - 8.0941\,Crowdview(5) - 6.9124\,Crowdview(6)$

The dependent variable indicates visitors' feeling for the intensity of use was still thought the ideal one compared to the other dependent variable, visitors' satisfaction perception with the footpaths in Chitou. The classification result (overall) accounts for 73.4 percent of the visitors' response to the probability of occurrence of crowded perception. The predictors in the RPM II model were the number of visitors who preferred pathway 12, 2, 21, 22 and 23 and the number of visitors who felt the visitor density was too high at the viewpoints including *Red Mansion, Campsites, Gingko Plantation, the Great Spiritual Tree, the University Pond* and the other amenity areas. The number of visitors who preferred pathway 12, 2, 22 and 23 and the number of visitors who felt the people density was too high at these viewpoints has a positive effect on increasing the possibility of a crowded feeling, while the number of visitors who preferred pathway 21 has a negative effect on increasing the probability of visitors' perception of intensive use.

5.7 The Application of Recreation Perception Models and Landscape Preferences

To increase the recreation carrying capacity in the popular amenity areas and footpaths in Chitou and enhance visitor enjoyment, more new viewpoints, their location and path routes must be considered. Some environmental and landscape factors including the forests and natural resources around and along the developing schemes, visitor amount control or the limitation of use for some pathways during some seasons in a year to allow ecological recovery, etc. have to be considered while planning to achieve minimum environmental impact and low economic cost.

For approaching the development target, topographic factors RPMs are developed for the prediction of the probability of visitors' recreation enjoyment and visitors' perception of the intensive use in terms of satisfaction and visitor density preferences. The final RPMs are obtained with Logistic Regression Analysis in this research. The topographic predictors are achieved for studying visitor perception and their relative importance in recreation planning are estimated by the coefficients in the RPMs which will be based on within GIS's scaling/ weighting operations to obtain the final combination map.

5.8 Summary

Regression analysis was used to build models of recreation preferences ('satisfaction' and 'crowd intensity'). The relationship of recreation preferences and their identified independent variables were investigated by the established equations. Linear Regression and Logistic Regression were two modelling methods used here. The third modelling method was created by adopting Factor Analysis before LR was run. This attempt (Factor Analysis) was made considering the large amount of variables in two questionnaires. The final model for visitor 'satisfaction' prediction was chosen from the results of these three modelling approaches. The same selection way applied to 'Crowd Intensity' prediction model. Both final models were obtained from LRA.

Except to investigate the probabilities of recreation preference occurrence, the independent variables of the Satisfaction Model (Equation 5.3) were further used for subsequent GIS analysis to produce the Satisfaction Map, which is one of the important element maps for recreation development exploration in this study. The mapping process of the Satisfaction Map will be detailed in the next Chapter.

CHAPTER 6. CREATION OF THE RECREATION SATISFACTION MAP AND ITS APPLICATION

The Recreation Satisfaction Map was created by mapping the independent variables (the preference for brownness, natural forest, landscape diversity, orangeness and pure forest) from the Recreation Satisfaction Model (Equation 5.3) established from the questionnaire analysis. In this Chapter, the mapping procedures which use the IDRISI software system are detailed.

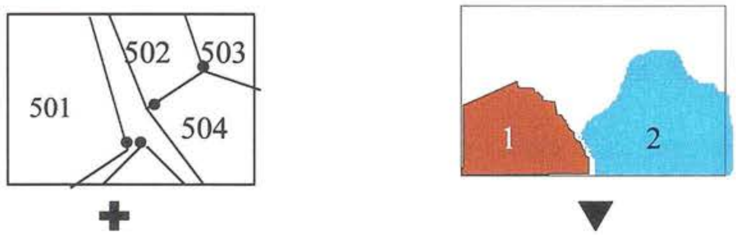
6.1 DATA SOURCE AND GIS DATABASE CREATION

6.1.1 Introduction to GIS and IDRISI

GIS is an information system which stores, analyses, transforms and displays both spatial and non-spatial data (attributes) (Aronoff, 1989). Nowadays, it is used often also as part of decision support systems. With advanced geo-modelling capabilities, the system is able to integrate spatially referenced data in a problem-solving environment (Hickin, *et al.*, 1991).

GIS utilises two types of information: spatial data (geographic data) and their attributes. Most GIS systems are classified as either raster-based or vector-based. For the former, the geographical features and their attributes are merged into unified image files and described as grid cells in a matrix, while in the latter, they are represented as a series of X, Y or X, Y, Z co-ordinates (Figure 6.1).

(A) (B)



ID	Tree-species	Area
501	101	6050
502	102	2900
503	401	2510
504	501	3410

VECTOR

0	0	0	0	0
0	0	0	2	0
0	1	0	2	2
1	1	2	2	2
1	1	1	2	2

RASTER

Figure 6.1 GIS representation systems' classification. (A) vector-based system (B) raster-based system

IDRISI is a raster-based geographic information and image based software system. It is designed to provide professional-level geographic research tools in a microcomputer environment, is easy to use and of lower cost than many other available GIS packages. IDRISI is ideal for use in environmental monitoring, natural resource planning and management, time series analysis, multi-objective decision support, uncertainty analysis and simulation modelling (Eastman, 1995). For these reasons, it was the software of choice in this study.

6.1.2 Definition and Classification of Chitou Data

The map data in this study can be classified into physical and recreational data. The former was derived from digitising paper maps and pre-digitised data from Chitou Park

Management. These data included Digital Terrain Models (DTM) (topography), soil, geology, waterways, roads, forests and compartment boundaries. The recreation data comprised of recreation resource data and recreation perception data. The recreation resource data, including a recreation facility map and pathway maps, were produced from digitising the Chitou Recreation Facility Distribution Map (1:5000) provided by the Park. Other Park publications, which were subsequently digitised for this study included bird and frog distribution maps. Park authorities also provided information concerning rare tree species and butterfly distributions. The related attribute data were derived from existing Park publications and field survey. Chitou's Planting Database was another source of recreation resource data (tree composition maps, the tree age distribution maps and the stand density maps, etc.). In order to explore the effect of recreation experience and preference, recreation perception data obtained from the questionnaire survey were also mapped. Table 6.1 contains a summary of data collected and used in this study.

Table 6.1 Classification and source of map data

DATA CLASSIFICATION	DATA SOURCE	SCALE	MAPS PRODUCED
PHYSICAL DATA-	✳ Pre-digitised Data	1:20000	Digital Terrain Model, soil, geology, waterways, roads, slope, aspect, road-building cost, forest types (small scale), compartment boundary , 3D maps
	✳ Data Digitised from Paper Maps	1:5000	sub-compartment boundary
RECREATION DATA-	✳ Data Digitised from Paper Maps	1:5000	forest species (detailed, from sub-compartment map),
Recreation Resource Data	• Distribution of Recreation Facility Map		recreation facilities, paths
	• Chitou's Publications	1:5000	bird and frog distribution, environmental impacts
	• Expert Opinion	1:5000	rare tree species, butterfly distribution
	• Chitou's Planting Database	1:5000	tree age, tree height, tree density and tree volume
Recreation Perceptional Data	• Questionnaire Survey	1:5000	**Recreation Satisfaction Map-** *including* natural forest, pure forest, landscape complexity, orange, brownness
		1:5000	**Crowding Perception Map-**

6.1.3 Digitising of Physical Features

The pre-digitised data from the Chitou authorities have a scale of 1:20000. Other Park data were obtained from paper maps (scale 1:5000) and were digitised using the ARC/INFO GIS software system. The extensive covering of man-made forest in Compartments 2, 3 and 6 was digitised from Forest Stand Maps of scale of 1:5000 produced in 1970 (the sub-compartment boundary map was obtained by the way). In addition, another pre-digitised Chitou Tract Plantation Distribution Map was obtained from the Park with a larger scale of 1:20000. All the digitising work was then completed and imported into IDRISI.

6.1.4 Importing Spatial Data into IDRISI

The Chitou Planting Database (Appendix D) includes data of stand number, planted species, planted year (age), tree height, planted areas, stand density and tree volume in the compartments. The data were spatialised, imported into IDRISI and individual maps were produced through the linking of compartment-id (identifier) with the other maps including the Forest Stand Map and the Chitou Plantation Distribution Maps (Appendix D and Figure 6.2).

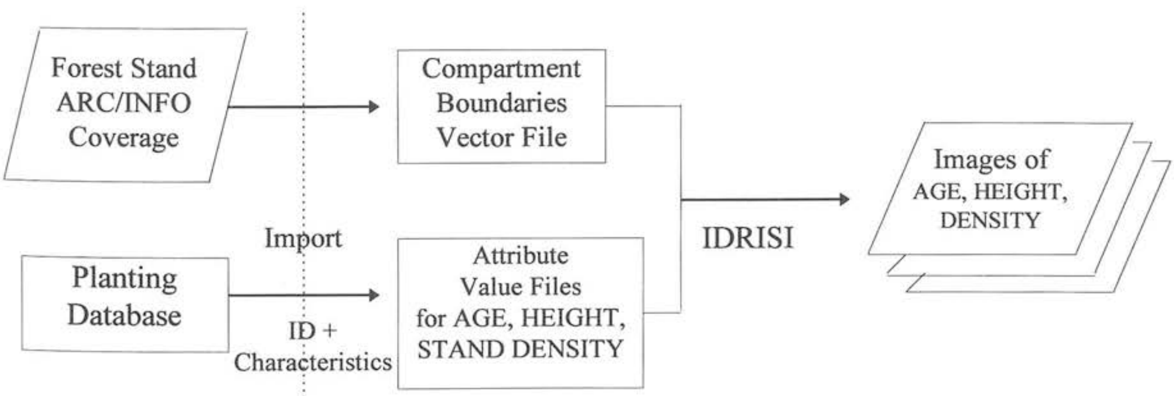


Figure 6.2 Process of extracting and importing database into IDRISI. (i.e. Importing tree age data)

6.1.5 Preparation of recreation and landscape map data and integration with GIS

Results from the Satisfaction and Crowded Perception Questionnaires (Chapter 4) show that visitors would welcome more viewpoints and paths. Effective methods for releasing visitor pressure from popular places and enhancing recreation quality were also expressed. In order to investigate these needs, a methodology for planning new viewpoints and path networks with the aid of GIS analysis was developed.

In order to identify suitable indices for examining recreation experience and preference, regression models of visitor preferences (RPMs) were built. This enabled the Satisfaction Preference Model (Equation 5.3) and Crowded Perception Model to be developed (Equation 5.5). The GIS mapping of the former is presented here. Five independent variables identified in the Satisfaction Preference Model were included; preference for brownness, natural forest, landscape diversity, orangeness and pure forest. The mapping procedures of these independent variables and their combinations will be described in Section 6.2. The resulting map, named the Recreation Satisfaction Map is one of four map elements. These maps will then be used to produced a final map which will be used to explore the location of new paths and viewpoints. Before describing this process, the production of the first sub-element maps is detailed (Figure 6.3).

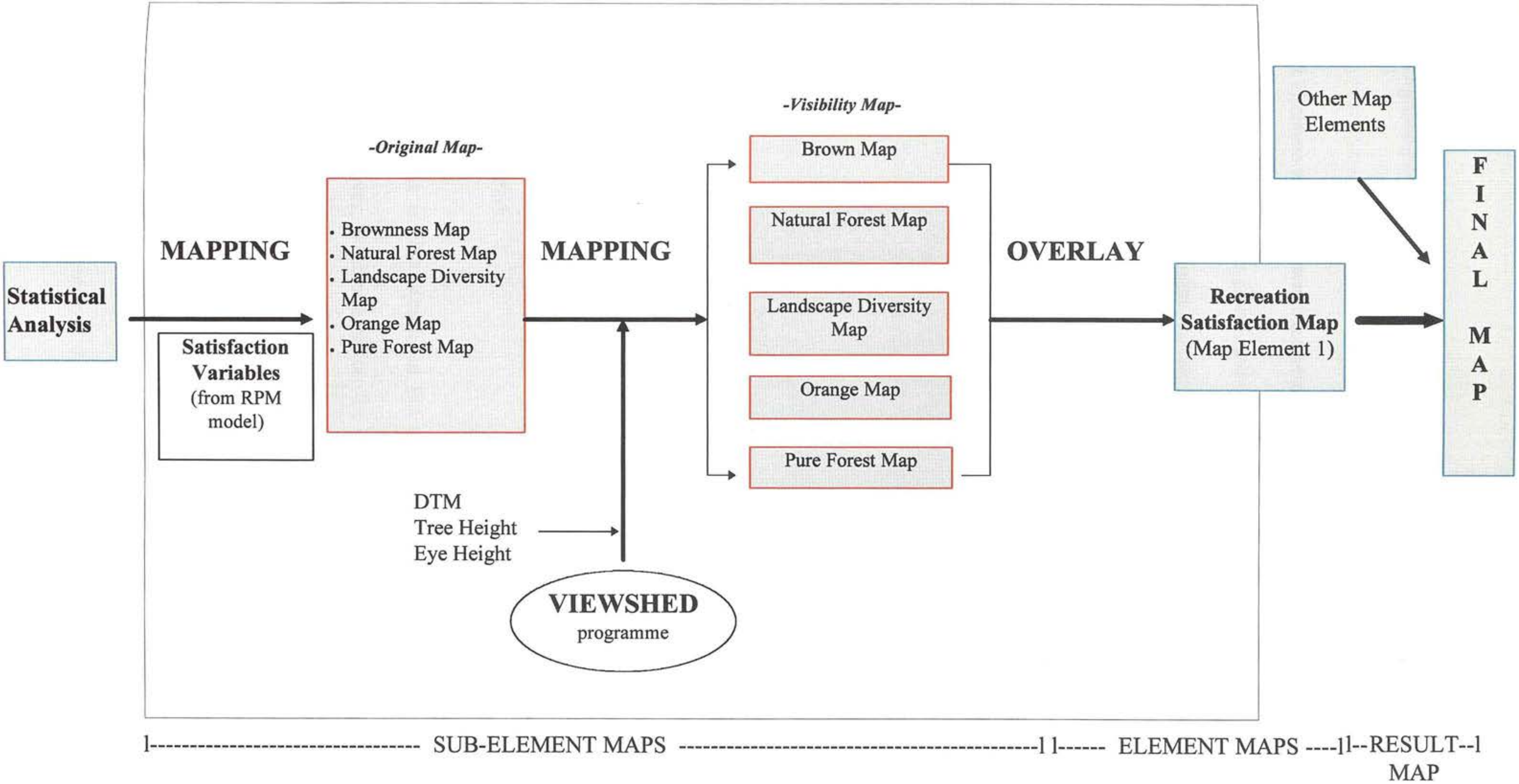


Figure 6.3 The mapping diagram of the Recreation Satisfaction Model using GIS. The Map Element 1, is one of 6 Element Maps which together comprise the final map.

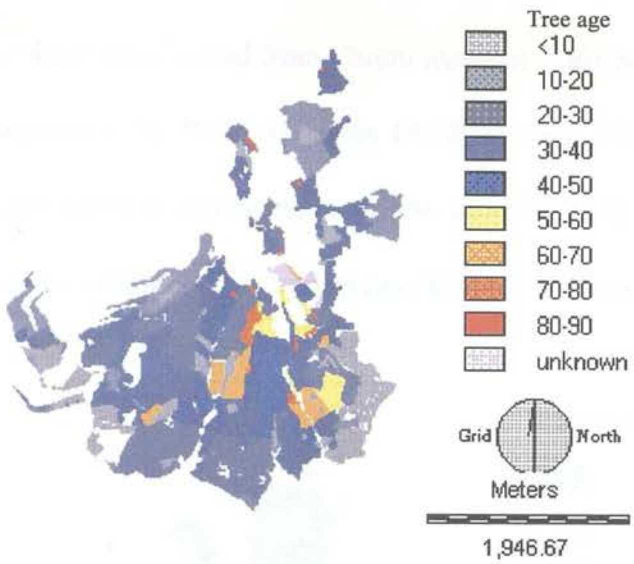
6.2 Digitising of Recreation Satisfaction

6.2.1 Creation of the Browness Distribution Map

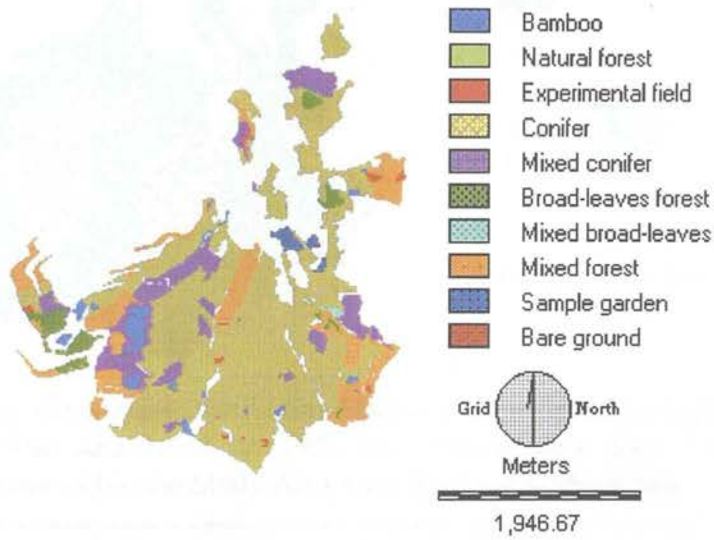
The study of plant colour distribution in Chitou is a new concept. Brownness was identified as an important determinant of visitor satisfaction by the Regression Model. In the high density forests of Chitou, the main component of brownness in the landscape comes from tree trunks, rather than canopies (Figure 6.4).

Figure 6.4 When visitors walk within the forests, they are embedded in 'a blanket of trees'. The main component of brownness in the landscape comes from tree trunks, rather than canopies in the Park.

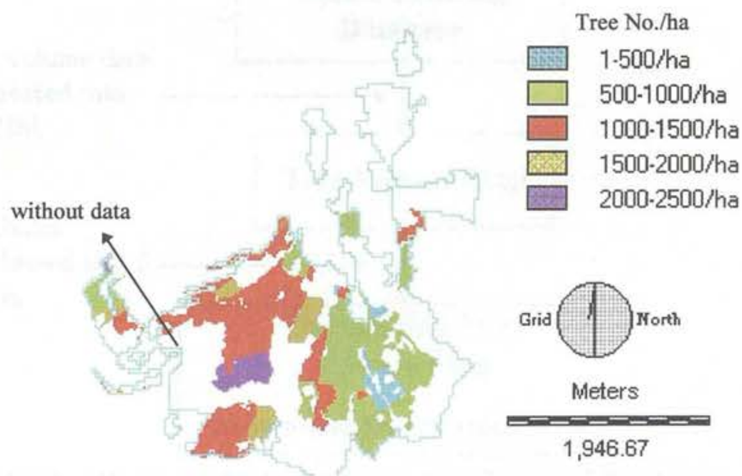
Some brownness is also present in the canopies, particularly where squirrel damage has occurred. However, no data exist on the distribution of such squirrel damage. Brownness was therefore assessed in terms of the visibility of tree stems. Trunks are more visible in mature stands, and the degree of visibility of the stems is greater in denser plantation forest, where the canopy is unbroken. Brownness was therefore assessed in terms of timber volume. The factors defining Tree Volume contain the combination of the tree age, tree species and tree density, and can be obtained from the Tree Volume Table (Figure 6.5a,b,c).



(a) Tree age map



(b) Tree species map



(c) Tree density map

Figure 6.5 Maps of a) tree age (scale of 1:5000; 1992 data), b) tree species (scale of 1:5000; 1992 data), and c) tree density (scale of 1:5000). Tree Density Map data used 1987 data and was incomplete, for reference only. Tree volume data contain the combination of tree age, tree species and tree density.

1993 tree volume database was derived from Chitou manager. This provided a good estimate of the extent of brownness in the Park (Appendix D) (Brownness Distribution Map is shown in Figure 6.6). The procedure of importing databases into IDRISI is shown in Figure 6.2, a diagram summarising the creation of brownness map is given in Figure 6.7.

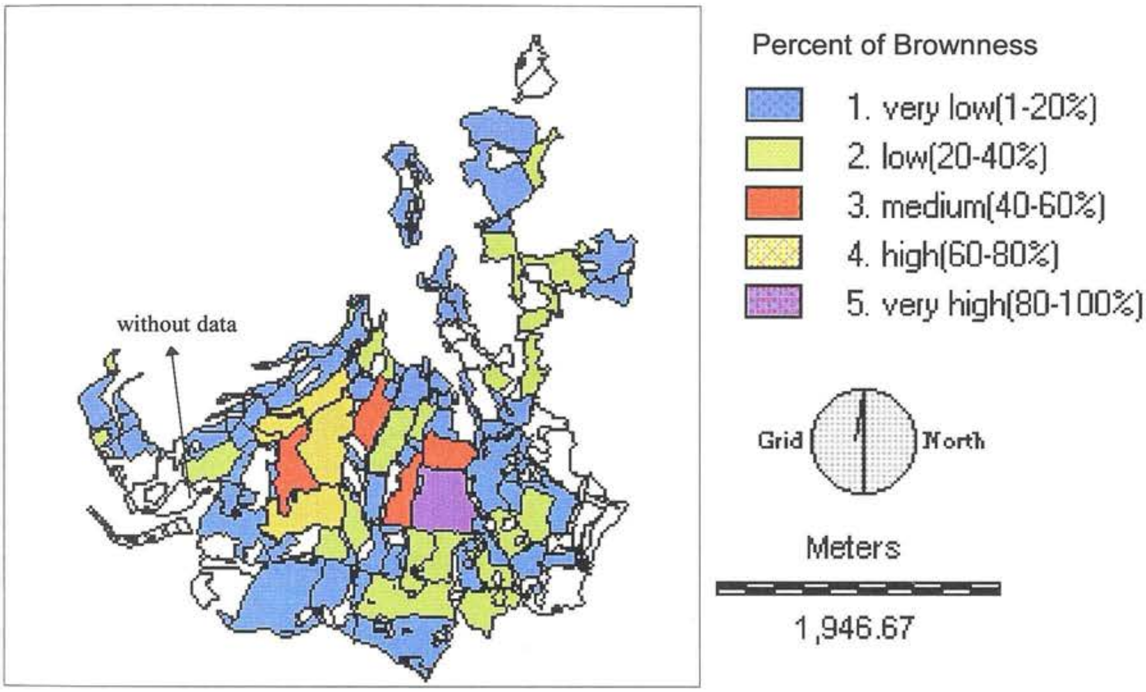


Figure 6.6 The resulting Brownness Distribution Map in scale of 1:5000 (originated from the Tree Volume Map). The data based on 1993 tree volume data from Chitou Planting Database. The white areas within the Study Area were the areas without data.

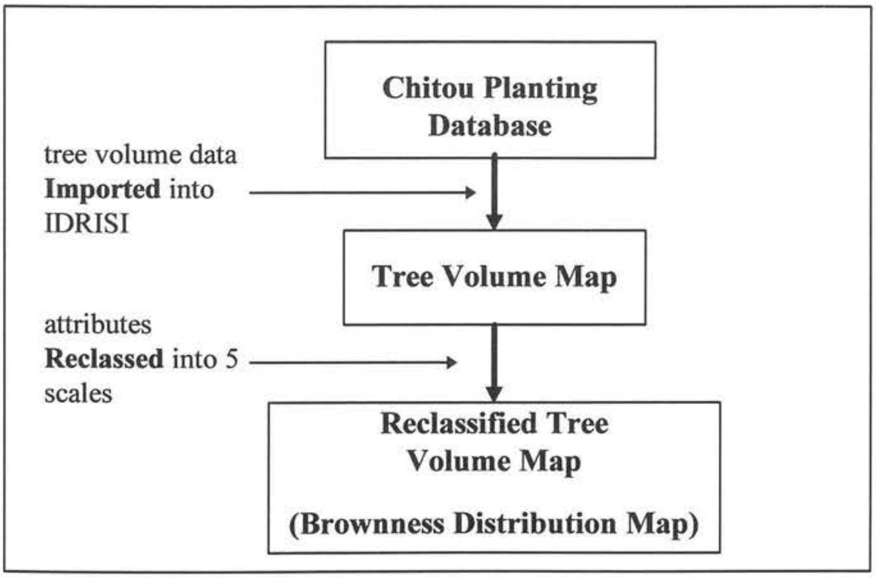


Figure 6.7 The diagram of the production of Brownness Distribution Map

To represent visitor preference for brownness, a linear scale from 1-5 was adopted (for low to high preference). 1 represented 1-20 percent brownness and 5, represented 81-100 percent. On this scale, the intermediate percentages were represented by 2, 3, and 4, accordingly. Visitor values were gathered from the Satisfaction Questionnaire. To link the design of the questionnaire, to the classification of volume data, tree volume data were also classified into the same five levels (Table 6.2).

Table 6.2 The relationship between the scales in the Brownness Distribution Map and tree volume data.

Tree Volume	Brownness
< 1527 (m^3/ha)	1-20%
<3057 (m^3/ha)	21-40%
<4567 (m^3/ha)	41-60%
<6078 (m^3/ha)	61-80%
<7615 (m^3/ha)	81-100%

The final classification of the brownness distribution map (Figure 6.6) is as below:

(1) very low percentage of brownness (1-20%)

(2) low percentage of brownness (21-40%)

(3) medium percentage of brownness (41-60%)

(4) high percentage of brownness (61-80%)

(5) very high percentage of brownness (80-100%)

6.2.2 Creation of the Natural Forest Map

The map illustrating the percent of natural forest in the Park was compiled from the forest species maps within both the study area (based on forest sub-compartment maps, scale 1:5000) and around the study (scale 1:20000). To differentiate between the two, the area around the study site was defined as Background Area. This is important since it provides some of the background to the Park and as such contributes to the satisfaction levels experienced from viewpoints within the Park. The forest species map was reclassified on the percentage of natural forest in each forest stand (sub-compartment). The percentage of natural forest in each stand in the study area was estimated from the combination of tree species and assigned a score as detailed below:

(1) Natural forest: 85 percent (mainly natural forest, conifers in marginal areas or bamboo mixed inside)

(2) Mixed conifers: 50 percent of natural forest (these contain some naturally regenerated trees and brushes. Considering the simplification of calculation, all mixed conifers were assigned a score as 50% of natural forest)

(3) Other forest types including man-made conifers, broad-leaved forests and bamboo, sample gardens and bare land: 1 percent of natural forest (to distinguish from outside Background Area).

The Background Area was classified into four homogeneous map units: bamboo, natural forests, conifers and farms. They were grouped into the same forest type percent levels as the study area, the exception was the conifer group which was defined as 10 percent of natural forest (natural forest remaining and self-growing trees and bushes are considered). The farm units were defined as 0 percent of natural forest.

The effect of recreation areas within the study area had to be concerned after both natural forest percentage maps from the study area and Background Area were overlaid. The recreation facility map contained no natural forest and was therefore defined as 0 percent of natural forest (Figure 6.8), and was overlaid on this composite map (study area and Background Area). An original natural forest percentage map was then created (Figure 6.9).

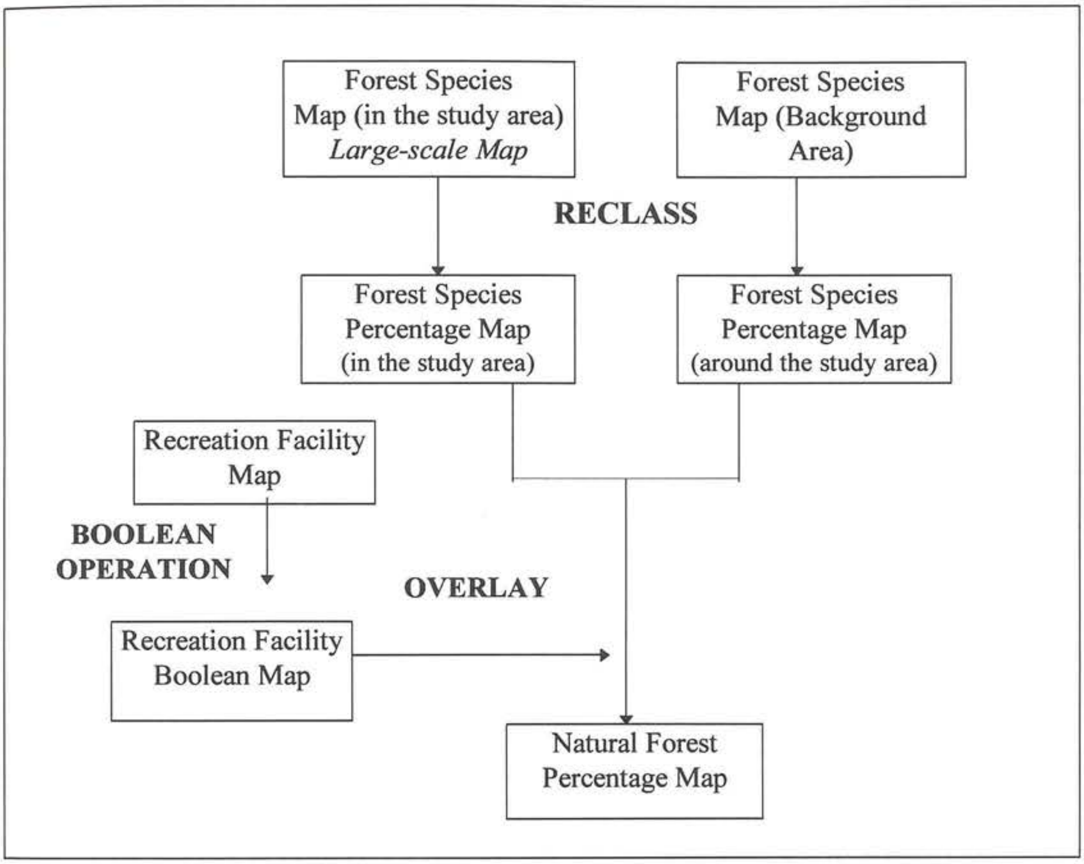


Figure 6.8 Process of the production of the Natural Forest Percentage Map (in Recreation Facility Boolean Map, the recreation facility areas were defined as 0 (containing 0 percent of natural forest) while the other areas were defined as 1 (background)).

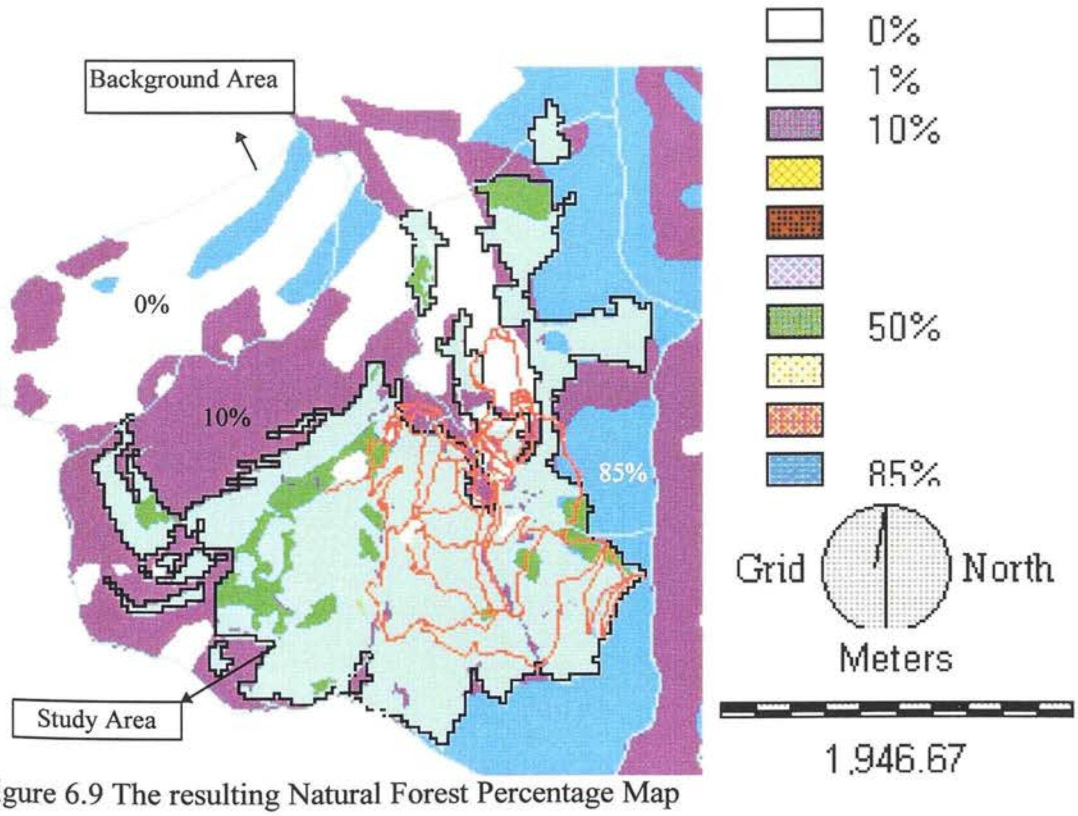
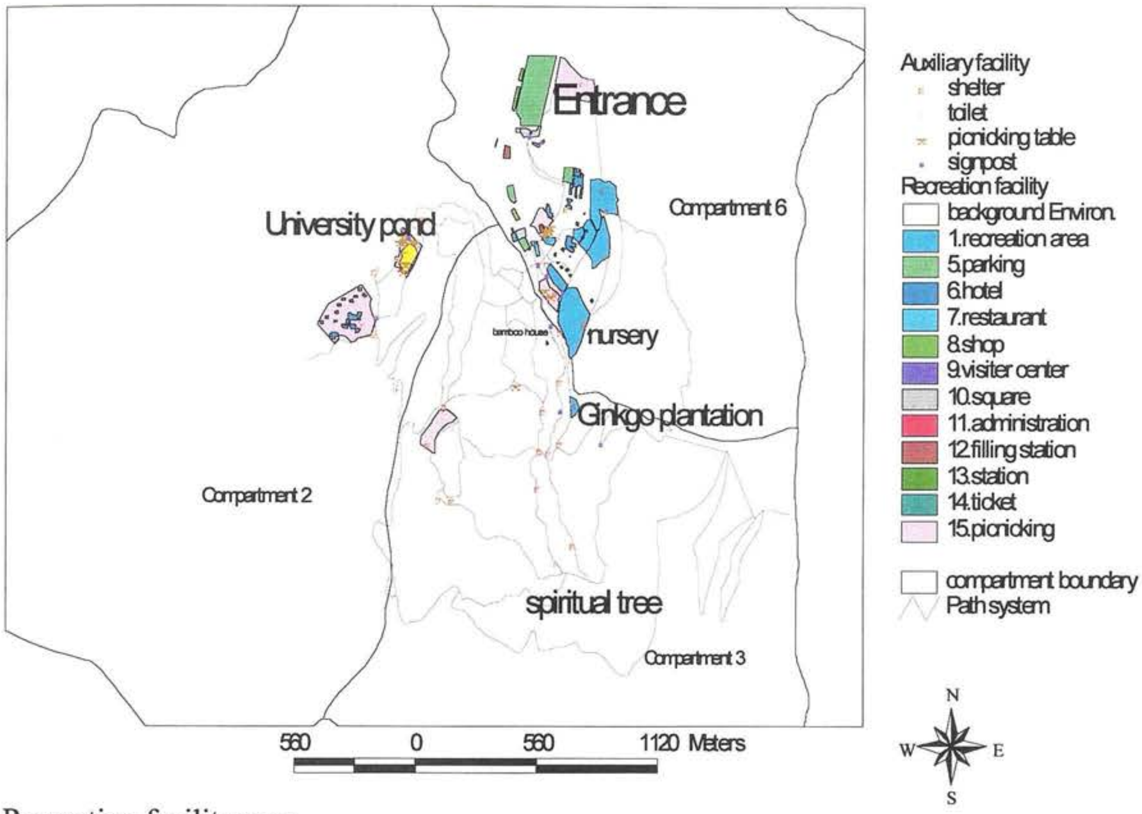


Figure 6.9 The resulting Natural Forest Percentage Map

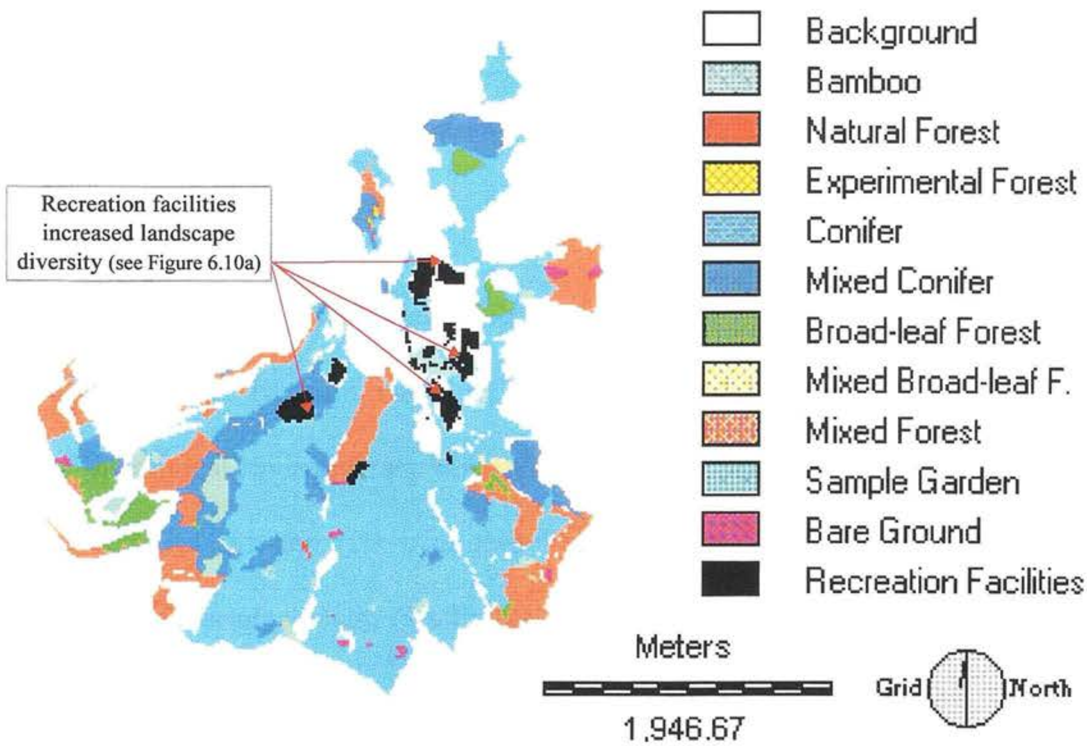
The Background Area was included in the natural forest map as it maybe visible from the natural forest from a viewpoint within the Park. Therefore, an area which is slightly bigger than the defined study area was considered. The same idea is applied to the pure forest percentage map.

6.2.3 Creation of Landscape Diversity map.

Both the forest species map (Figure 6.5b) and the recreation facility map (Figure 6.10a)(both are sub-element maps) were used to construct the landscape diversity map. It should be emphasised that the various types of recreation facilities in the area have a considerable effect on landscape diversity. The two sub-element map layers were then combined through overlay. The components and variety of the resulting map were then used to compute landscape complexity (Figure 6.10b). The production of the landscape diversity map is summarised in Figure 6.11.



a) Recreation facility map



(b) The resulting landscape basic map

Figure 6.10 The resulting landscape basic map (b) from the overlaid of the forest species map and the recreation facility map(a).

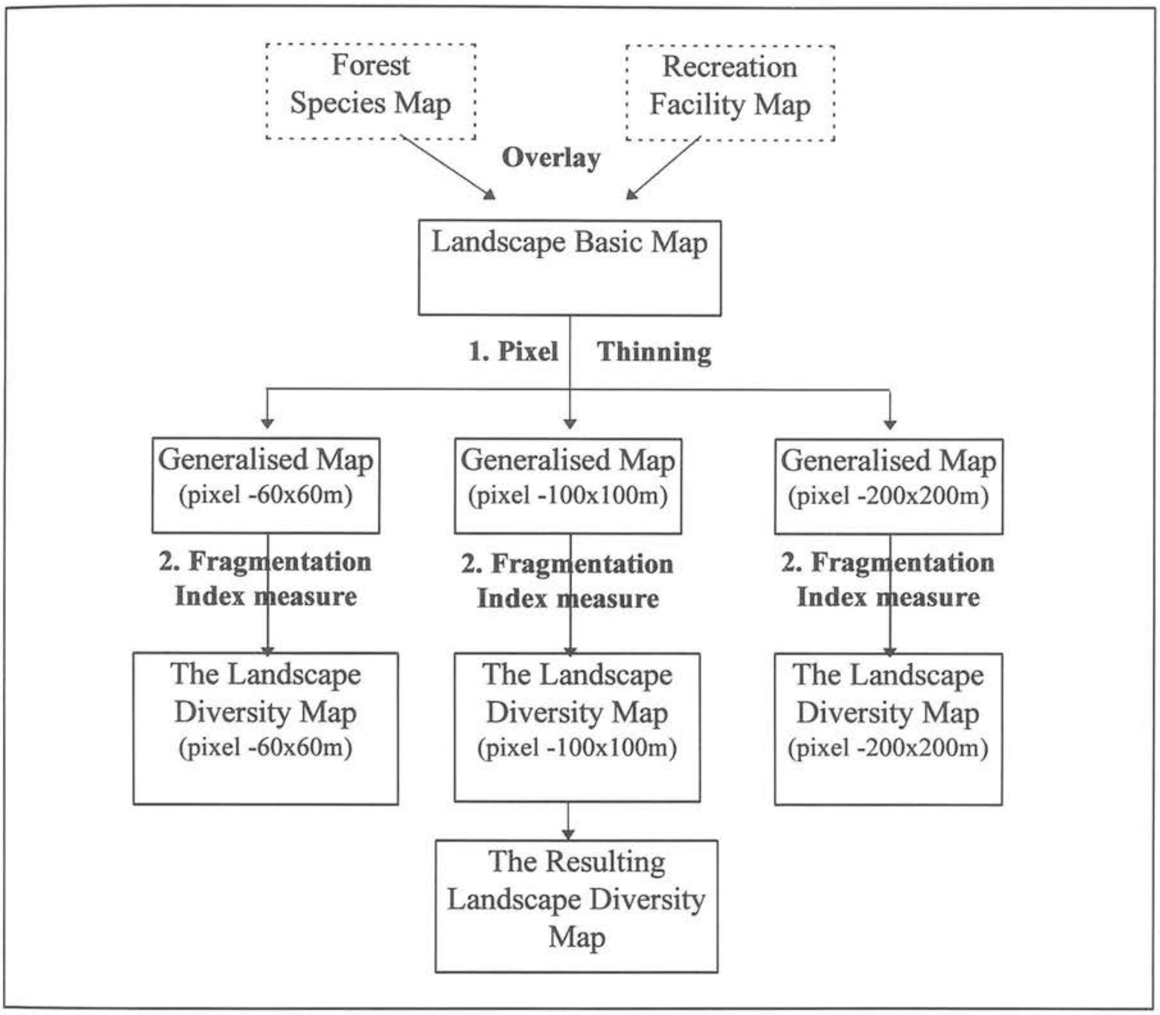


Figure 6.11 Summary: Production of Landscape Diversity Map

As Figure 6.11 shows, two IDRISI modules are involved in producing the resulting landscape diversity map. The first, was used to produce a generalised landscape map. The resolution of the original landscape map was reduced using pixel thinning. This involved the selection of every 3rd, 5th and 10th pixel (pixel size 60x60m, 100x100m and 200x200m, respectively) from the original image (see Figure 6.12). This reduced the number of rows and columns of the Landscape Diversity Map. The contraction images with pixel sizes of

60x60m, 100x100m and 200x200m were then created (the Generalised Map). The image reducing procedure applied aims to simplify and characterise the landscape pattern.

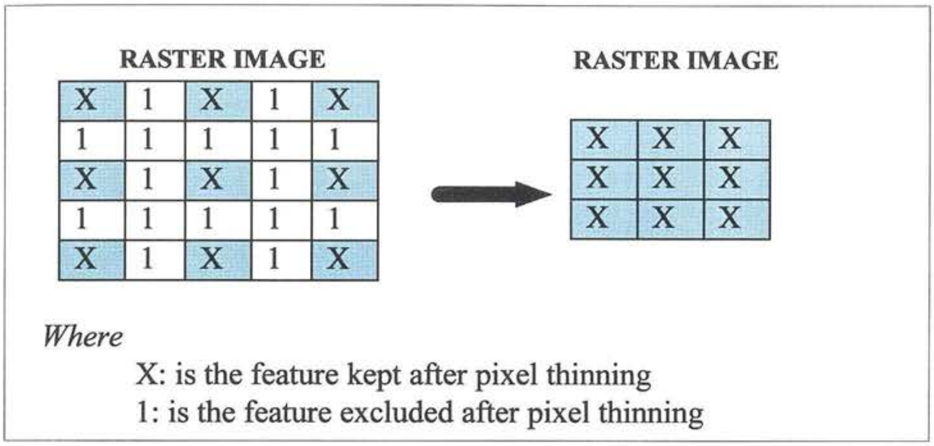


Figure 6.12 The procedure for pixel thinning. This involves the selection of every 3rd pixel, for example, from the original image. The number of rows and columns of the Landscape Diversity map were reduced in this manner.

The second stage in Landscape Diversity mapping involved estimating the variability in each 3x3 pixel window of each of the three contraction images. The complexity (diversity) of each pixel was assessed as outlined in Figure 6.13. At this stage, the Fragmentation Index measure was employed (Equation 6.1)

Fragmentation (F) = (n-1) / (c-1) Equation 6.1

where n = number of different classes present (different from the centre cell)
c = number of cells considered (always 9)

For example

PIXEL WINDOW

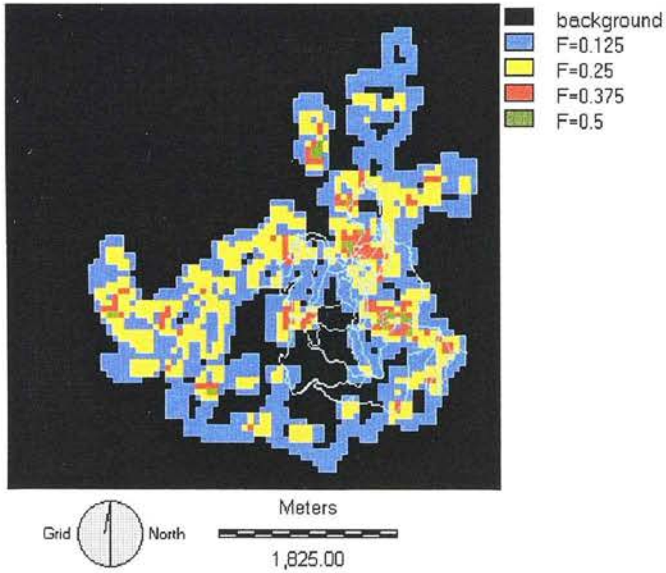
6	2	2
5	1	3
4	4	3

Centre Pixel

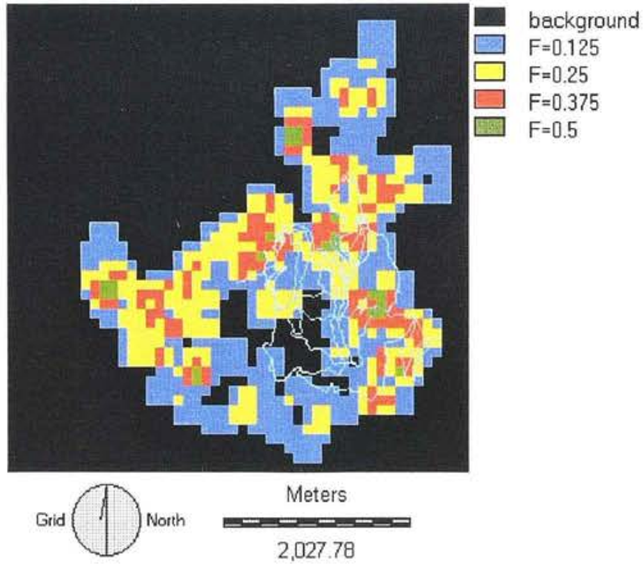
n = 5
c = 9
F = (5-1) / (9-1) = 4 / 8 = 0.5

Figure 6.13 Example of use of the Fragmentation Index measure. In the pixel window, the same numbers stand for the homogeneous landscape units. Many different numbers illustrate a higher landscape diversity.

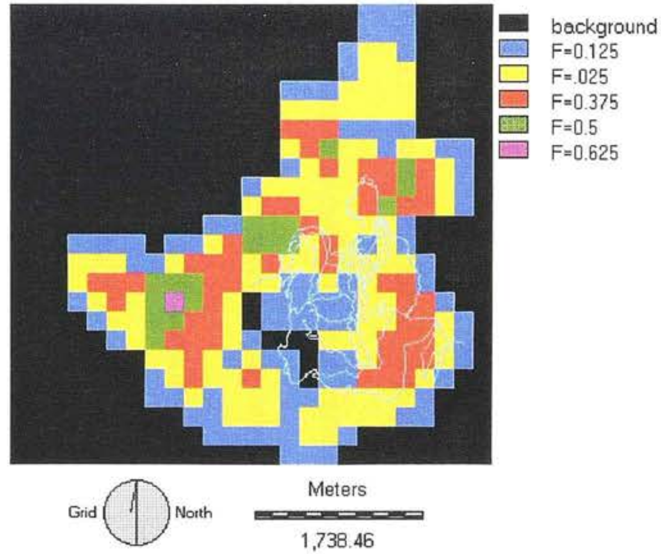
The Fragmentation Index (F.I.) is one of the measures of landscape fragmentation (Monmonier, 1985; Eastman, 1992) and was used to complete the estimation of landscape diversity within the study site. The results of F.I. are scale- dependent. 100 m was taken subjectively, in order to match the scale of observer perception. On comparison with the original overlaid map of forest species and the recreation facility map (Figure 6.13), the map with pixel size of 100x100m was chosen as the resulting Landscape Diversity Map (Figure 6.14(a), 6.14(b), 6.14(c)).



(a) 60x60m



(b) 100x100m



(c) 200x200m

Figure 6.14 The resulting Landscape Diversity Maps using the Fragmentation Index Measure. (a) Landscape Diversity Map with pixel size of 60x60, (b) Landscape Diversity Map with pixel size of 100x100, (c) Landscape Diversity Map with pixel size of 200x200. (F=Fragmentation Index)

6.2.4 Creation of the Orange Distribution Map

The Orange Distribution Map shows the presence and extent of dominance of the colour orange. The map also illustrates visitor satisfaction perception of orangeness to the Park obtained from questionnaire result in a map representation. The study of the distribution of orangeness, similar to that of brownness distribution, was new to the Park. Experts were consulted to produce this map. A map showing the location of the forest compartments, sub-compartments, popular viewpoints and pathway systems (Appendix I) was sent to plant classification and plant ecology experts in Chitou who were familiar with the area. A brief background to the present study was provided and the experts were asked to mark the location where orangeness (from either leaves, flowers, fruit or the other tree bodies) could be seen on the map.

The response maps were scanned using a scanner and the orange areas showed on the resulting image were digitised to extract the defined areas and produce an orange distribution map using IDRISI Display Launchers screen digitising software (Figure 6.15).

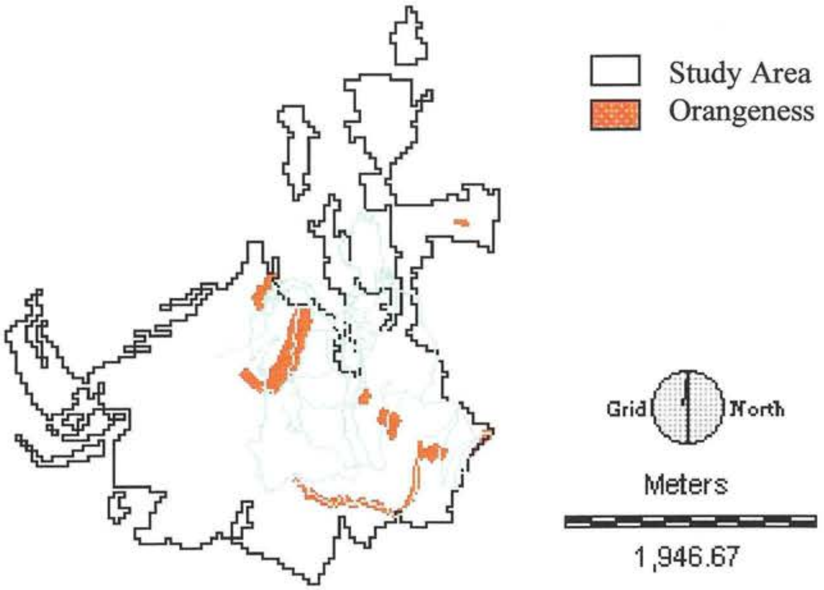


Figure 6.15 The Orangeness Distribution Map.

6.2.5 Creation of the Pure Forest Map

A pure forest map was created from the forest species map (including the Study Area, scale 1:5000 and Background Area, scale 1:20000). A pure forest was defined as a monoculture forest which may include pure conifers, pure broad-leaved forests or bamboo forest. The Background Area was again included in the pure forest map in order to capture visibility considerations. The percentage of pure forest in each forest stand (every polygon unit represents a forest stand within the study area (refer to Figure 6.5b) was given as below, based on the forest type (data from the Chitou Planting Database, Appendix F);

(1) Man-made conifers, broad-leaved forests and bamboo plantation: 85 percent of dominant tree species.

(2) Man-made mixed conifers, broad-leaved forests: 50 percent of dominant tree species.

(3) Natural forest: 10 percent of dominant tree species.

(4) Other plantations: 1 percent of dominant tree species (distinguish from the area outside Background Area).

The Background Map had the same four land use types as mentioned in Section 6.2.2 (the natural forest percentage map). Percentages were defined with a similar standard as the pure forest previously detailed; conifers (85%), bamboo (85%) and natural forest (10%). In addition, the farms were defined as 0 percent of pure forest.

Both maps from the study area and Background Area were overlaid and recreation facilities were defined as 0 percentage of pure forest. An original pure forest percentage map was then created (Figure 6.16).

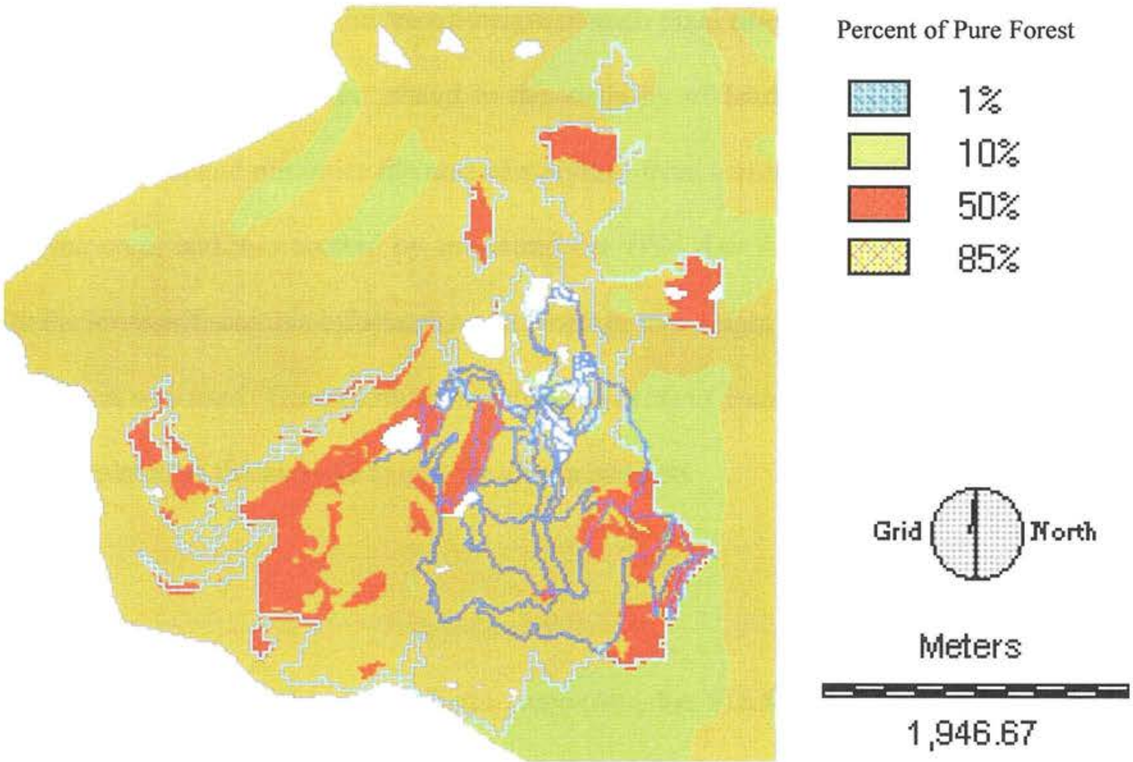


Figure 6.16 The resulting Pure Forest Percentage Map.

6.3 Creation of Recreation Satisfaction Map

6.3.1 Terrain Variety and Tree Height Variability

The previous sections have shown how the five sub-element maps (brownness distribution map, the natural forest percentage map, the landscape diversity map, the orangeness distribution map and the pure forest percentage map) were produced. When examining the mountainous environment in Chitou, it is important to consider how terrain variety will affect the visibility area from any viewpoint and the composition of landscape diversity. Therefore, the terrain factor was included by employing the DTM model to run a viewshed programme (Figure 6.3). In this procedure, 1.5 meters was set as the average height of the visitors' eyes and added to the terrain height of each pixel (the raster image unit).

Tree height is another factor related to the visibility of landscape. High trees can create a screening effect and minimise the area of visibility from a view. Therefore, a tree height map was required, and was created by importing the 1994 data from Chitou Planting Database. For the areas without this information, the average tree height of the dominant tree species in each stand was used. The maximum tree height (11m) of bamboo plantations after two years was calculated as the average height for all the bamboo.

6.3.2 Creation of a recreation satisfaction map using the VIEWSHED programme

To complete the preparation of the sub-element maps used to produce the Recreation Satisfaction Map, a DTM, tree height map and VIEWSHED programme were required. The resulting product was the creation of a 'mountainous world'. The five landscape sub-element maps were all transferred into 3-D maps in this way (Figure 6.17). To achieve this, visibility at each pixel was estimated. For example, visibility of the landscape was examined by computing for all cells the percentage of natural forest visible from each pixel located in different elevations (with 1.5m average eye height). In addition, the tree height within each pixel was considered. The procedure was approached by using a VIEWSHED module in IDRISI. The same mapping stages were then applied to the other four sub-element maps.

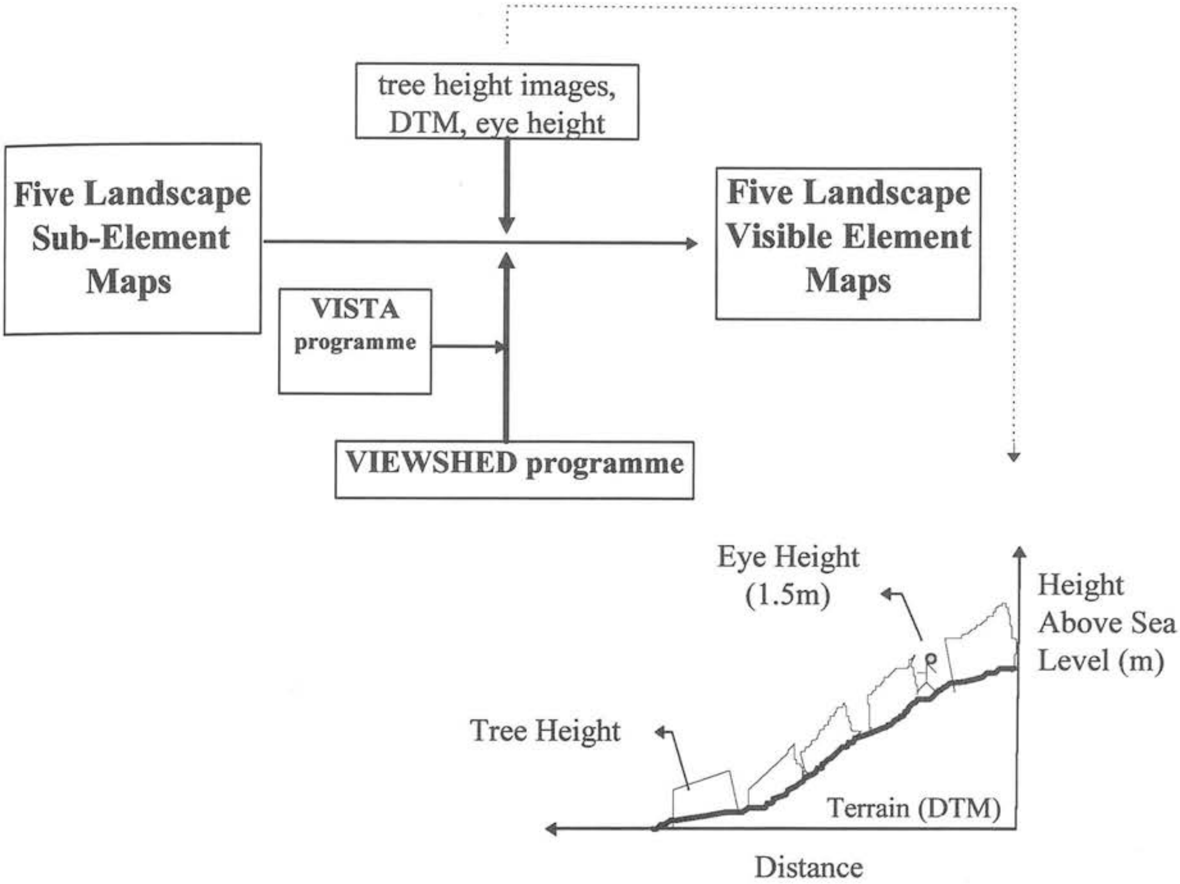


Figure 6.17 The procedure which forms the landscape images into 'mountainous world'.

In order to go through all the pixels (123 rows x 127 columns = 15621 pixels in each element map) for the five sub-element maps of Recreation Satisfaction, a separate VIEWSHED module had to be repeated every time. A programme, VISTA, written in Borland Dephile 2.0 computer language (Appendix G) was used to carry out this extensive process.

The resulting images were referred to as; the brownness visibility percentage map (Figure 6.18(a)), the natural forest visibility percentage map (Figure 6.18(b)), the landscape diversity visibility percentage map (Figure 6.18(c)), the orangeness visibility percentage map (Figure 6.18(d)), and the pure forest visibility percentage map (Figure 6.18(e)).

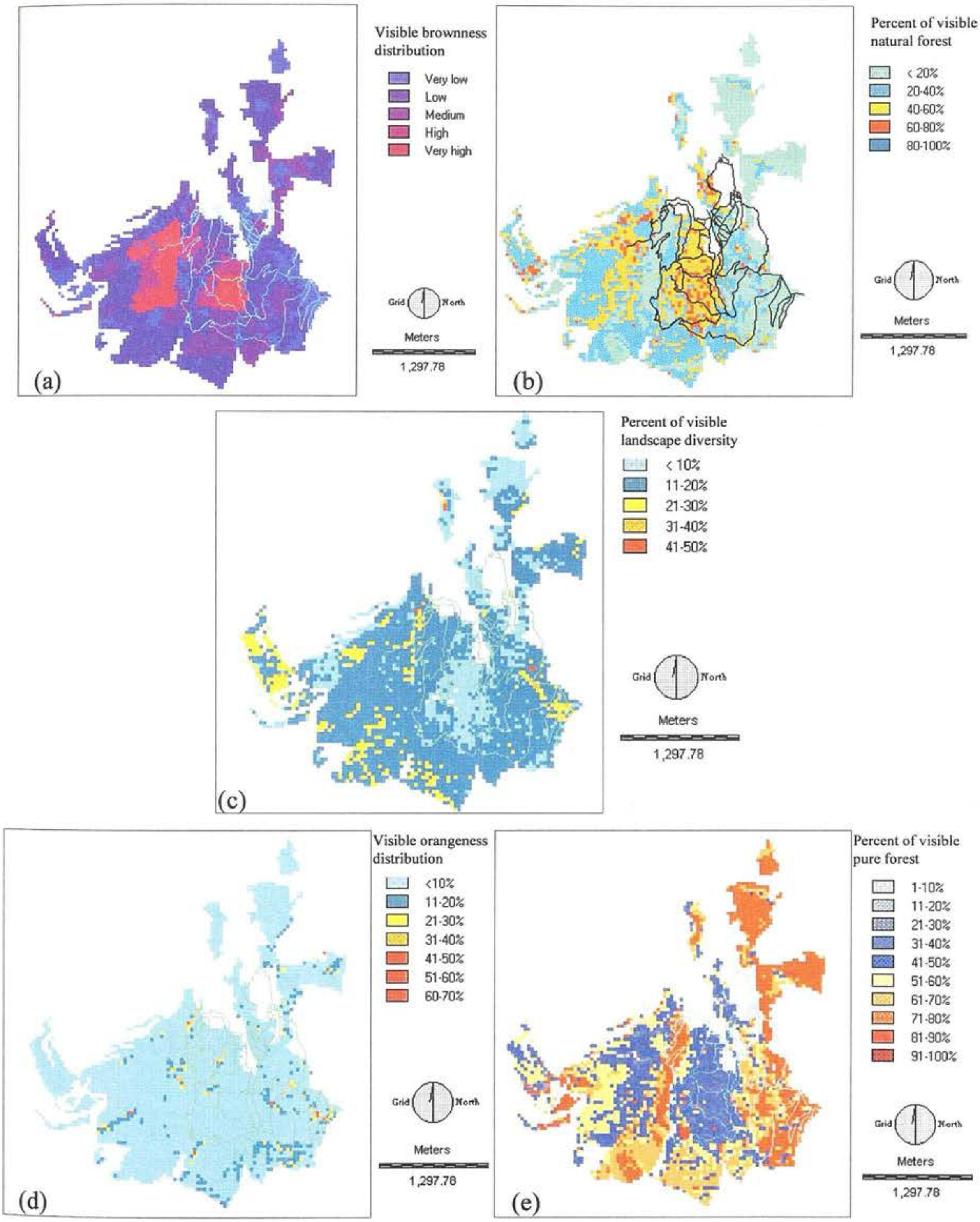


Figure 6.18 The resulting images using VIEWSHED programme were referred to as; the brownness visibility percentage map(a), the natural forest visibility percentage(b), the landscape diversity visibility percentage map(c), the orangeness visibility percentage map(d), and the pure forest visibility percentage map(e).

The Recreation Satisfaction Map can then be created by employing the arithmetic calculation on images using the IDRISI SCALAR module (adding, subtracting, multiplying, etc. the pixels in the input image constant value) and the IDRISI TRANSFOR module (which can convert the data values in an image to the natural logarithms of those values) based on the Satisfaction Recreation Perception Model. The production steps of the Satisfaction Map (Figure 6.19) is listed below and a macro command was programmed for this series operations (Appendix H):

STEP 1*: Z = 0.1965[1] + 1.1283 brownness visibility percentage map[1] + 0.6062 the natural forest visibility percentage map[1] - 0.7708 the landscape diversity visibility percentage map[1] - 1.5427 the orangeness visibility percentage map[1] -0.9182 the pure forest visibility percentage map[1] [[1]: using **SCALAR** for the calculation of each sub-element map; using **OVERLAY** to combine them] (Appendix E)

STEP 2*: MULTIPLY Z by -1 [using **SCALAR**]

STEP 3*: e^{-Z} [using **TRANSFOR**]

STEP 4*: ADD 1 [using **SCALAR**]

STEP 5*: RECIPROCAL $1/(1+e^{-Z})$ [using **TRANSFOR**]

*Refer to

Recreation Satisfaction Model-

Probability of Satisfaction Occurrence = $\dfrac{1}{1+e^{-Z}}$

where

Z = 0.1965 + 1.1283 BROWN_Y + 0.6062 FOREST5_Y - 0.7708 LANDSCAPE4_Y - 1.5427 ORANGE_Y - 0.9182 PURE FOREST_Y) **Equation 5.3**

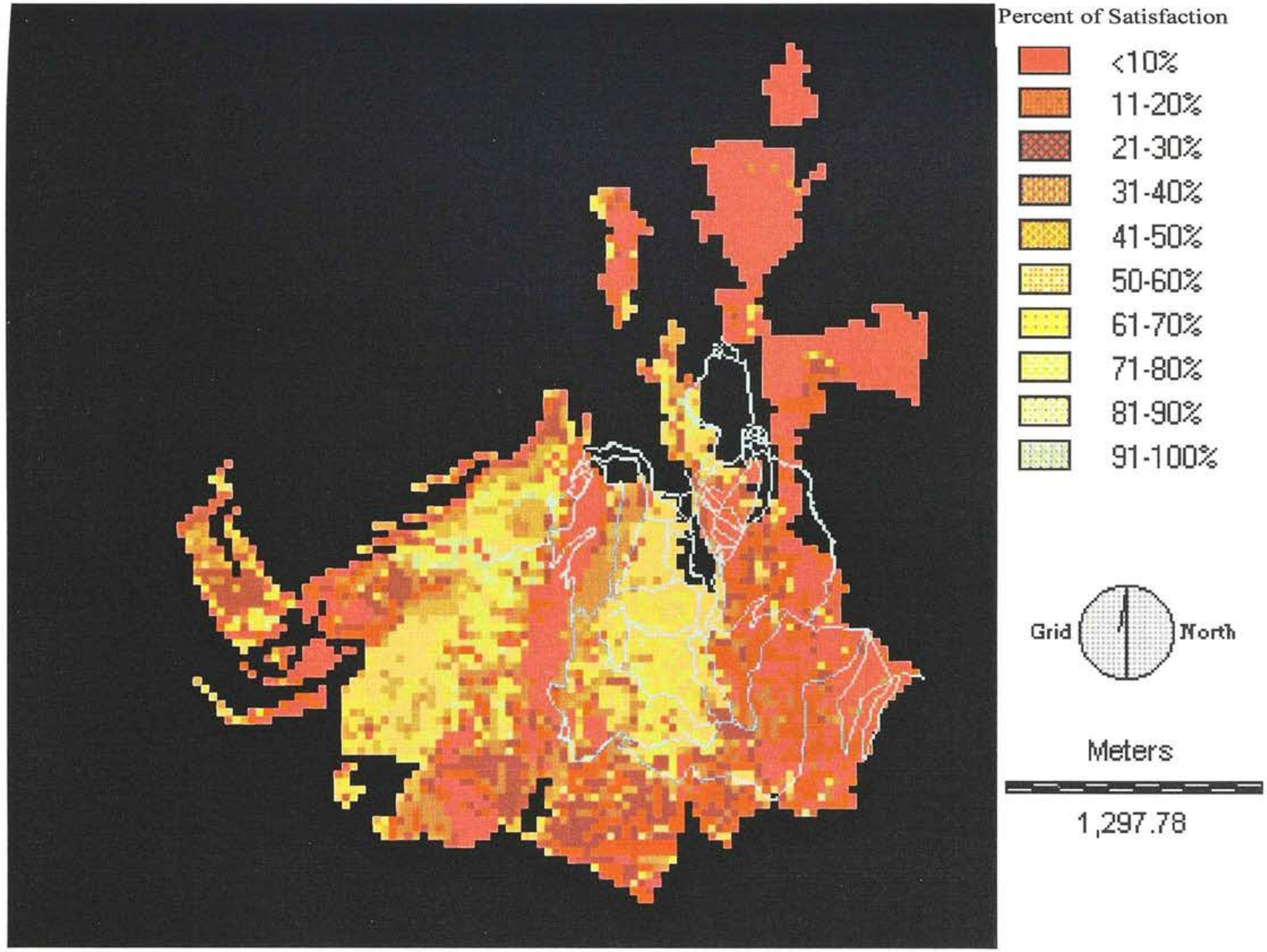


Figure 6.19 The final Recreation Satisfaction Map developed from five sub-element maps through Recreation Satisfaction Model calculation. The value of each pixel showed the percentage of 'Satisfaction' occurrence.

The extent of Satisfaction is an important factor in the identification of new viewpoints and route selections. In addition, the visible area from each pixel in the Park also needs to be considered. A Visibility Map was therefore created based on the tree height map using the same viewshed approach as previous detailed (Figure 6.20). The resulting Visibility Map was used for the evaluation of selected paths and viewpoints.

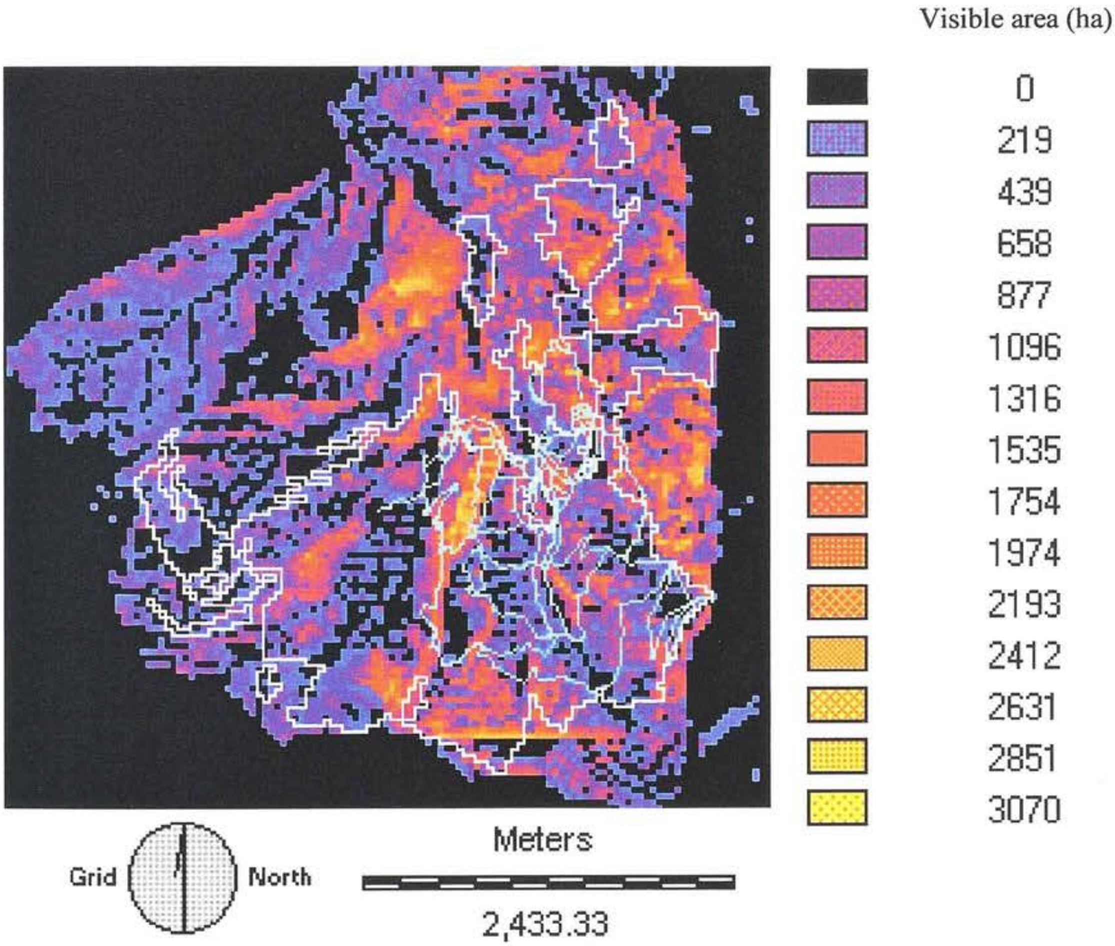


Figure 6.20 The resulting Visibility Map. Each value on the map represents the visible areas from each pixel. The Background Map areas were the limitation of this calculation.

The other map factors considered for this development target were cost map, recreation resource map, remoteness map and environmental consideration map. These element maps will be detailed the following Chapter.

CHAPTER 7. VIEWPOINT AND PATH ROUTE SELECTION

7.1 Overview and Introduction to Multi-Criteria Evaluation

Before undertaking natural resource or recreation management, it is important that during the planning phase a set of objectives, and means for reaching these objectives be identified. It is common to identify multiple-objectives and such multi-objective management has been traditionally undertaken in Chitou Park. It is also common for the multiple objectives not to be equally derivable, and in order to plan in this situation, a set of weights, reflecting importance, may need to be developed and assigned to the objectives. This framework was adopted in this study and a Multi-Criterion Evaluation tool (MCE) suitable for use in spatial analysis was used to investigate the outcomes of various management scenarios. This module, IDRISI MCE, is a Multi-Criteria Evaluation tool running within IDRISI which analyses alternative scenarios. MCE has been used in this project to examine the problem of viewpoint and path development. As MCE runs, a set of criteria (element maps) are combined to achieve a specific objective based on the proximity of the criteria. Criteria can be divided into two types, the first, management objectives, otherwise known as Factors, and the second, Constraints, are both in map format. The former are usually of continuous nature (i.e. remoteness of distance or the satisfaction extent), and they indicate the relative suitability of certain areas for management objectives. The latter should be in a Boolean map format, that is, 1 or 0 (yes/ no), with 0's in the areas illustrating the exclusion from consideration, and 1's highlighting the favoured areas. For instance, protected areas were defined as zero and excluded from development.

Four Factor Maps were considered here: recreation satisfaction, road-building cost, recreation resources and levels of remoteness. The two Constraint Maps of MCE included steep slopes (> = 25 degrees) and wildlife (rare trees and frogs reserves) (Figure 7.1).

Three different combinations of the 4 Factor Maps (based on different priorities) were produced. Each of these scenarios represented a different solution to the problem of path and viewpoint selection. The 4 Factor Maps were then weighted and combined with the 2 Constraint Maps using MCE.

Before MCE was run, these Factor Maps had to be standardised into the range of 0-255 (256 levels) with IDRISI modules. This weighting process ranks all factors into degrees of relative importance. There are two MCE Constraint Maps defined as slopes greater or equal to 25 degrees and wildlife areas (including rare trees and frogs within the Park). The constraint areas have to be excluded from recreation development by assigning the value zero before conducting MCE (Figure 7.1). The resulting three suitability maps for each scenario are then used for new viewpoint and path selections. 'COST DISTANCE' module and 'PATHWAY' modules were employed for the final solution.

In Figure 7.1, the summarised planning procedure of recreation development (new viewpoint and path selection) through the MCE application is shown. After comparing the resulting 'Suitability Map', the best scenario and the resulting new paths and viewpoints were chosen.

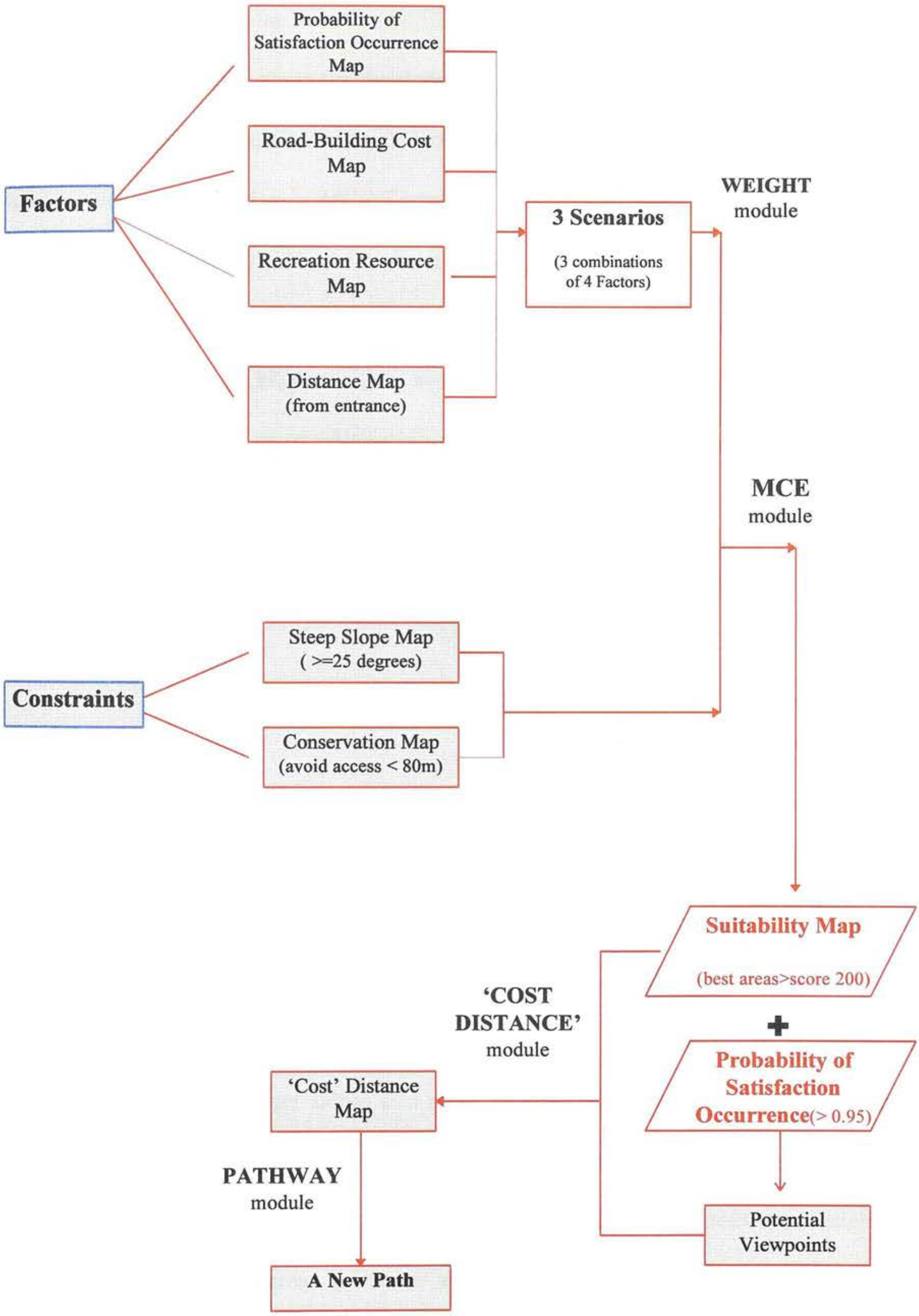


Figure 7.1 Flow diagram of new viewpoint and path planning using MCE evaluation. ('COST DISTANCE' module generates a distance/proximity surface ('cost distance surface') where distance is measured as the least effort in moving over a friction surface.)

7.2 Satisfaction Factor Map

When choosing suitable areas for development, areas with high levels of visitor satisfaction are preferred, and so the (Recreation) Satisfaction Map was redefined as a Factor Map. As satisfaction was defined as a MCE Factor, the Satisfaction Map previously produced was reclassed into 0-255 IDRISI standardised levels with the use of STRETCH module. The higher the ranks (higher satisfaction of occurrence probability), the more preferred the pixel. The Satisfaction Factor Map was then available for the MCE WEIGHTING process to be assigned a weight based on its relative importance to the other 3 Factors (Figure 7.1).

7.3 Cost Map

7.3.1 Data Preparation

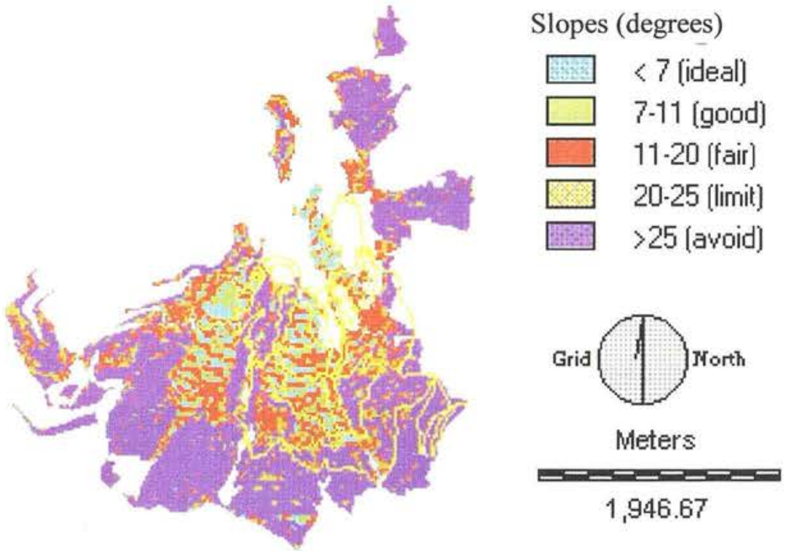
Several variables combine to determine the cost of road-building cost (building cost). These include slope, soil type, geology, remoteness, logging cost (tree density), and bridge construction. As this study is a methodological exploration, then for reasons of simplification, the slope factor was chosen to represent the road-building cost. Slope factor was adopted to represent road-building cost as an example, as slopes are an important factor for road construction. Larger slopes cost more in terms of soil deposits, labour and material consumed. When slopes are greater than 15 degrees, steps are required (Agattec, 1983) and costs rise. When the areas are steeper than 25 degrees, a shallow contour step design should be considered and these areas are better avoided. Any slopes greater than 30 degrees are prohibited for development based on the National Park Law in Taiwan.

The slope factor in the creation of the Building Cost Map was considered. The slope criterion was employed as both a Factor and Constraint in this recreation development study. Slope was considered a Factor in the less steep the areas and, the lower the slope the lower building cost. When a slope becomes a Constraint, areas with greater than a 25 degree slope become prohibited for development. The mapping procedure of the Cost Map is described below. The Constraint slope mapping will be detailed in the following Environmental Sensitivity Map section.

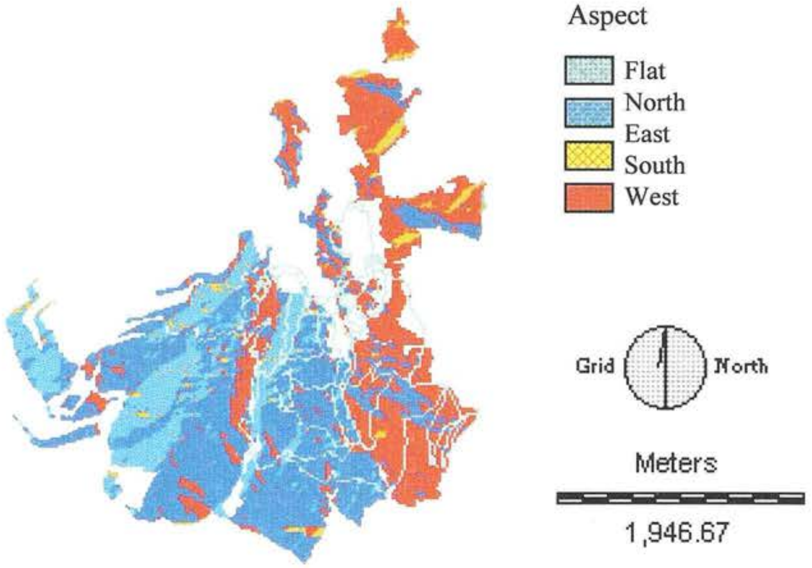
7.3.2 Creation of Building Cost Map

The Building Cost Map was produced from the Slope Map and this map was calculated from a DTM image. Initially, this map was produced by calculating the maximum slope for each pixel from the Park's DTM and 40m pixels (scale 1:20000). This result was presented in decimal degrees (Figure 7.2(a)). An Aspect Map containing the maximum slope faces and a Hill Shaded Map, both for the purpose of illustration (display only), were created (Figure 7.2(b), (c)), to show the topography in the Park.

(a) the Slope Map



(b) the Aspect Map



(c) the Hill Shaded Image

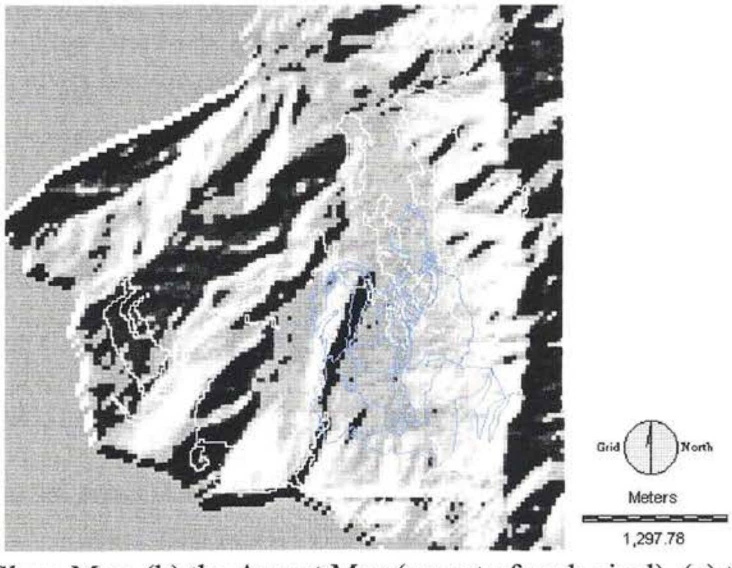


Figure 7.2(a) the Slope Map, (b) the Aspect Map (aspect of each pixel), (c) the Hill Shaded Map (shading for DTM in Chitou including the Study Area and the Background Area).

The relationship of road-building cost to slope variation was developed. The Map which indicated slopes equal to or less than 25 degrees was extracted with the RECLASS command and represented in the Building Cost Map (Figure 7.3).

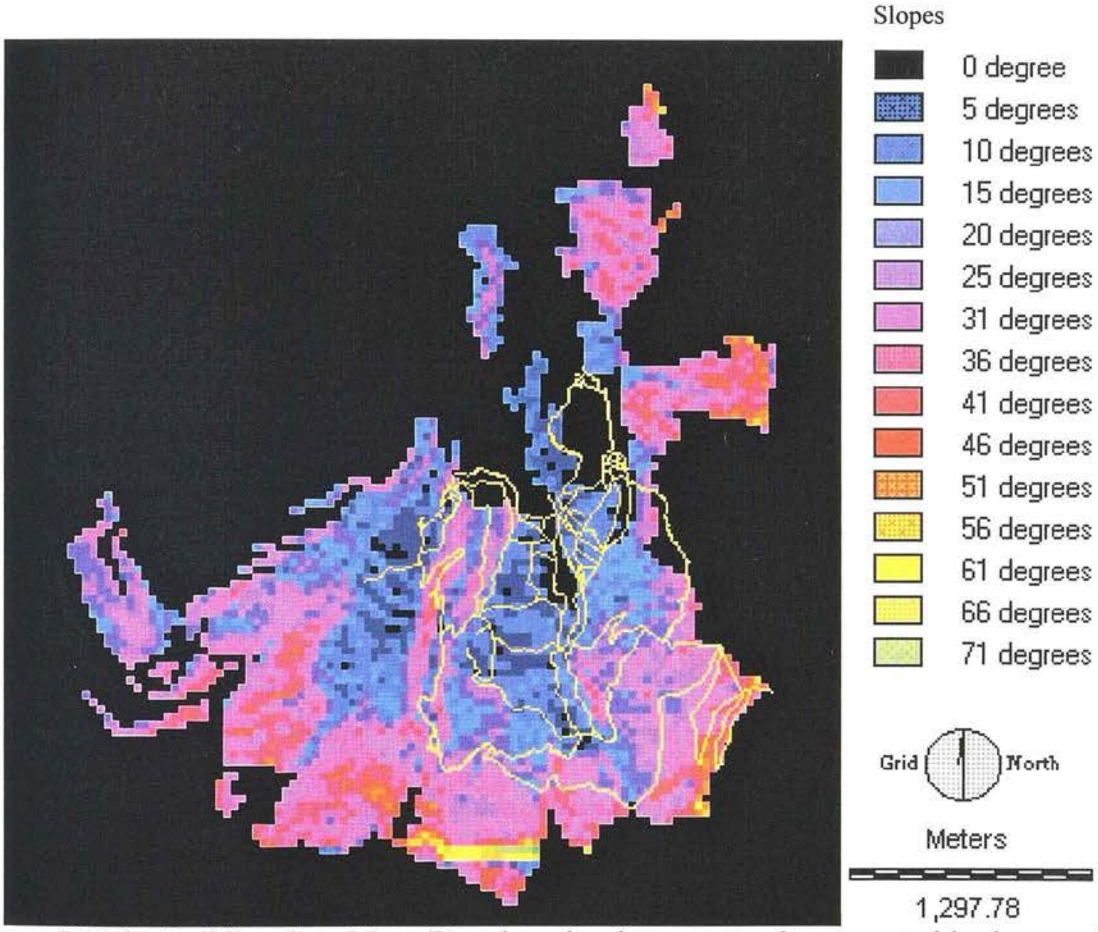


Figure 7.3 The Building Cost Map. (Based on the slope map and represented in degrees. The lower the slope the lower building cost.)

As previously indicated, the attributes of a Factor Map have to be standardised into 256 levels. The Building Cost Map was then formatted into these levels using IDRISI STRETCH modules. In an IDRISI standardised map, the higher values represent those areas which are considered as preferred areas. The map ranged from 0-255 representing low cost to high cost and was then reversed through subtracting a temporal map in which all pixels have a value of 255. The lower building cost in the Building Cost Factor Map was then re-assigned higher values. The data were then available for MCE evaluation to examine the best areas in the Park for recreation development (Figure 7.4).

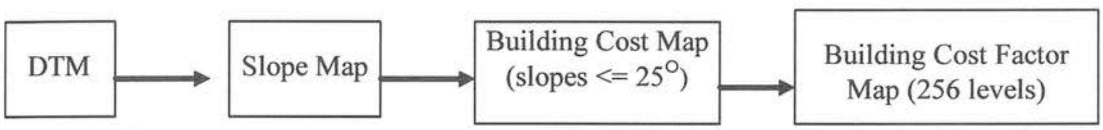


Figure 7.4 The production procedure of the Factor Map of Building Cost Map.

7.4 Recreation Resource Map

Wildlife, including birds and butterflies, have a high recreation value. Both groups are very mobile and the impact from road-building on their habitat and life cycle is probably not as damaging as in the case of rare trees and therefore they were defined as recreation resources. Ornamental trees including *Taxodium distichum* (Taxodiaceae), *Gingko biloba* (Ginkgoaceae) and Square Bamboo (*Chimonobambusa quadrangularis*) were also considered as recreation resources in this study. Recreation resources were assumed to be Factors while MCE was performed.

Three recreation resources (birds, butterflies and ornamental trees) were digitised using the IDRISI DISPLAY LAUNCHER function (on screen digitising) to produce the Recreation Resource Map. The spatial parameters were copied from the Current Path Map (scale 1:5000). As Neyland and Brown (1994) suggested, the effect of artificial disturbance of logging and road construction on the structure and floristics of cool temperate rain forest patches requires a buffer zone at least 40m wide to be placed around the zone. Thurmond, *et al.* (1995) and Sitoe (1996) suggested a similar width of buffer zone for avian and natural forest conservation. This width of buffer zone (40m) is therefore used for most wildlife species (birds, butterflies, ornamental trees and, frogs) in this study. The buffer zone was adopted here to keep the three recreation resources free from large development disturbance. It is not meant, however, to prevent visitors from observing or viewing the wildlife. As recreation resources were treated as a Factor in Multiple-Criteria Evaluation, for new viewpoints and paths, the nearer the buffer zone of recreation resources, the better. After buffering, the three wildlife maps were overlaid and the Recreation Resource Map was produced (Figure 7.5). The buffer widths adopted are shown in Table 7.1.

Table 7.1 The buffer widths adopted for each wildlife resources in Factors and Constraints.

Criteria Classification for MCE Evaluation	Natural and Recreation Resources	Buffer Zone (for wildlife resources & keep from development)	Requirements of Criteria for MCE
Factors	• Recreation Resources-		⇒ near the areas; the nearer, the better.
	Birds	40 m	
	Butterflies	40 m	
	Ornamental Trees	40 m	
	• Cost	-	
	• Satisfaction	-	
	• Distance	-	
Constraints	• Conservation Species-		⇒ avoid the areas
	Rare Trees	80 m	
	Frogs	40 m	
	• Slope	-	

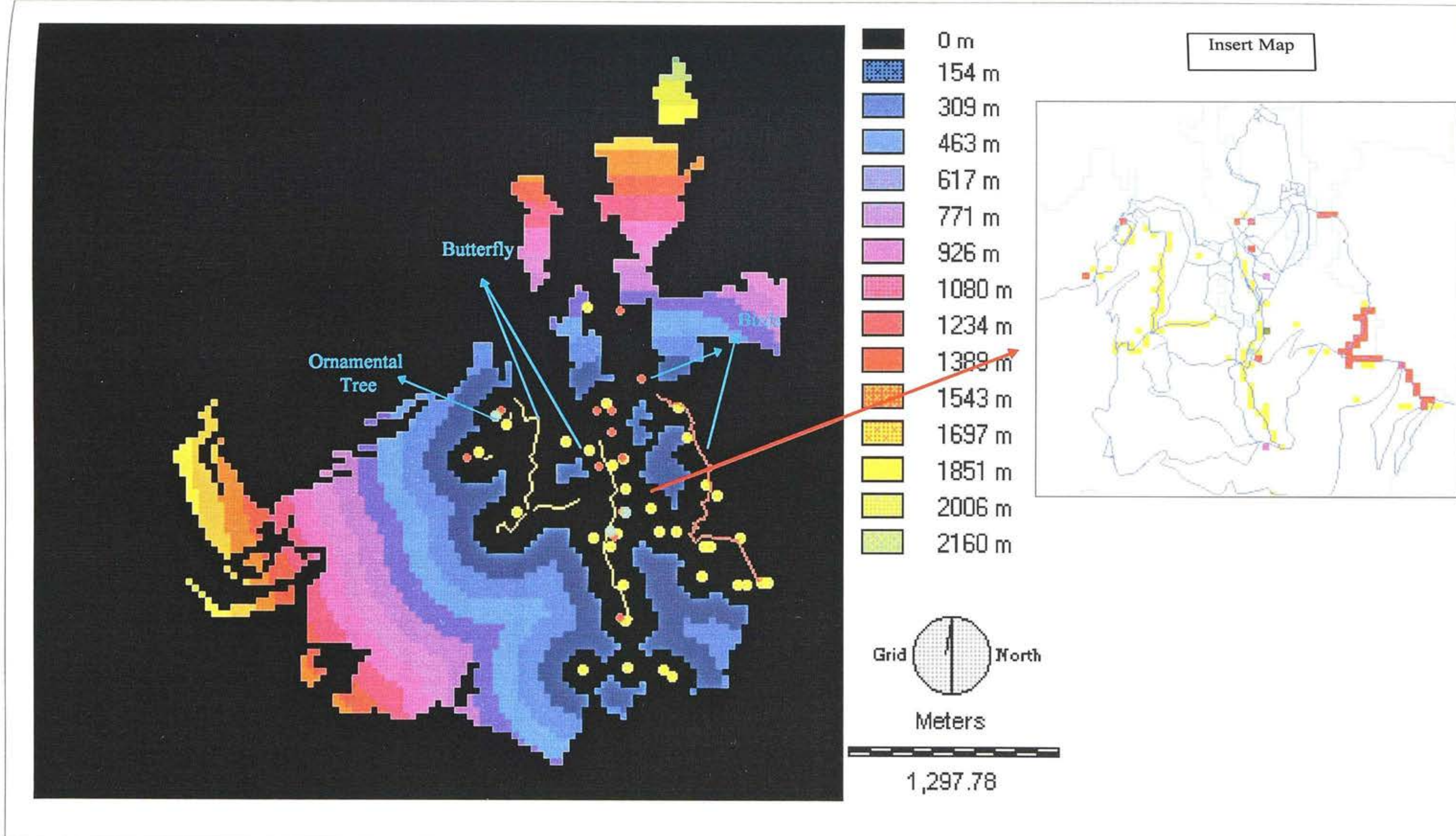


Figure 7.5 The Recreation Resource Map which presented the distance started from the areas where wildlife resources were locatred (The insert map shows the distribution of recreation resources on current path network).

Before assigning the relative importance (weights) to the Recreation Resource Map and running the MCE command, the standardised Recreation Resource Factor Map was created ranging from 0-255 in the IDRISI environment. As previously indicated, the higher the rank, the higher the preference for the area in an IDRISI standardised map. The same reverse process as was carried out in the Cost Map (Section 7.3) was performed on this standardised map. The Recreation Resource Factor Map now had the wildlife location closer areas with higher values.

7.5 Distance Map

7.5.1 Introduction to Distance Data

The Distance Map data came from the second questionnaire, which examined crowd intensity. This map was used to investigate the effect of Remoteness (Figure 7.6). Information from path visitation was adopted to show to what extent visitors prefer remote pathways and what effect this preference has on visitor enjoyment. Figure 7.6 shows the 'distance data' initially obtained from the path visited experience study (Appendix B-Question: *which pathways were visited,* in the Crowd Intensity Questionnaire). The distance information (average and maximum distance) of each pathway was calculated from the IDRISI Current Path Map (in all 23 pathways were identified). Both results showed that not many visitors went to remote pathways (pathway 19, 20, 21,22 and 23). The visitor rates of these pathways were less than 10 percent. Therefore, a path built far away from the Park entrance would not be popular. As a result, the nearer viewpoints and pathways would be preferred for recreation planning and decision making.

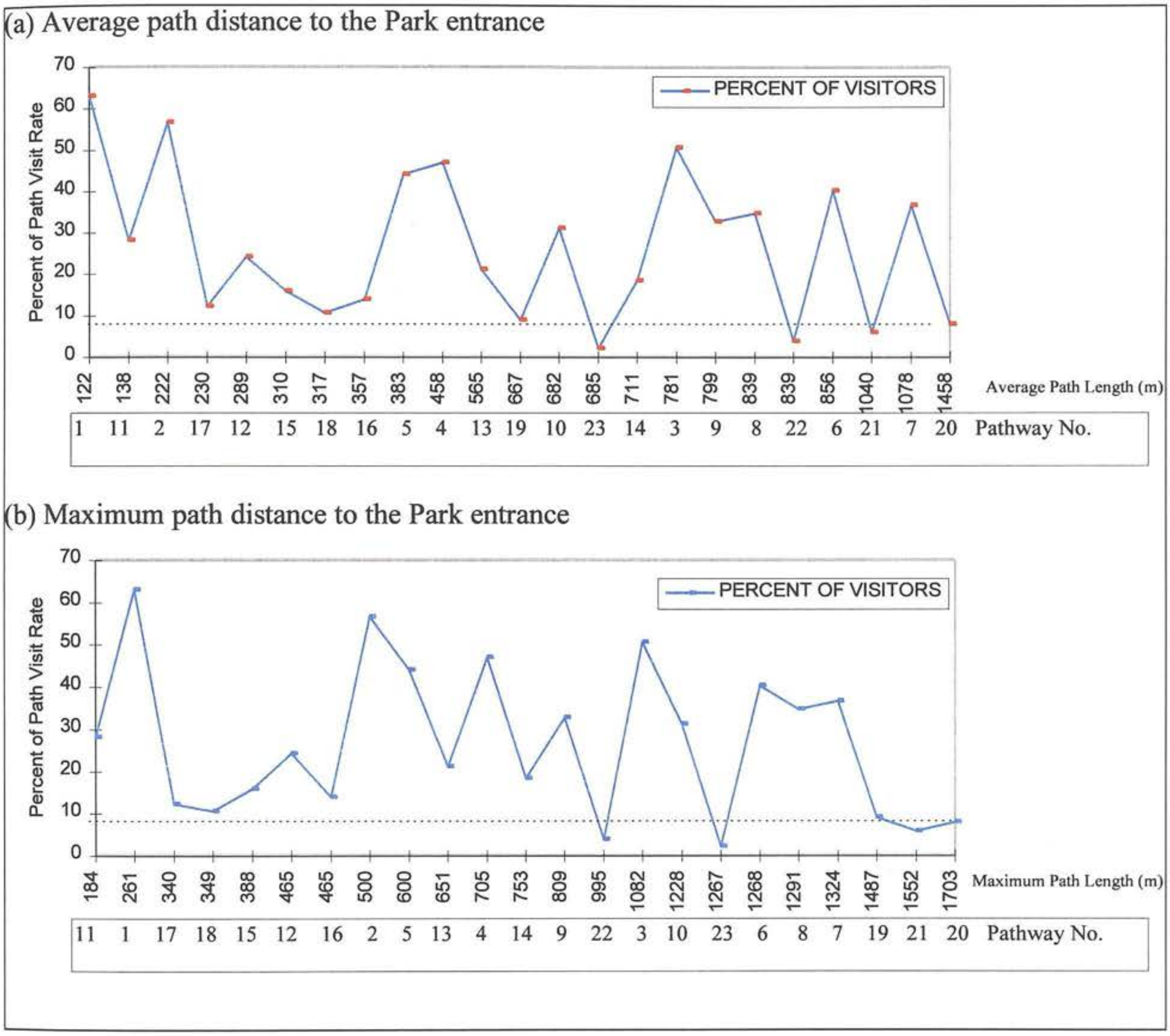


Figure 7.6 The relationship between visitor distribution in the Park and remoteness (Distance data were obtained by calculating the 'average' and 'maximum' distance of each pathway (1-23) to the Park entrance using IDRISI)

7.5.2 Creation of Distance Map

A start point near the entrance was chosen as the centre for calculation. Next, the distance between each cell and the start point was calculated through an IDRISI DISTANCE module. A map presenting continuous concentric circles around the start point was produced (Figure 7.7).

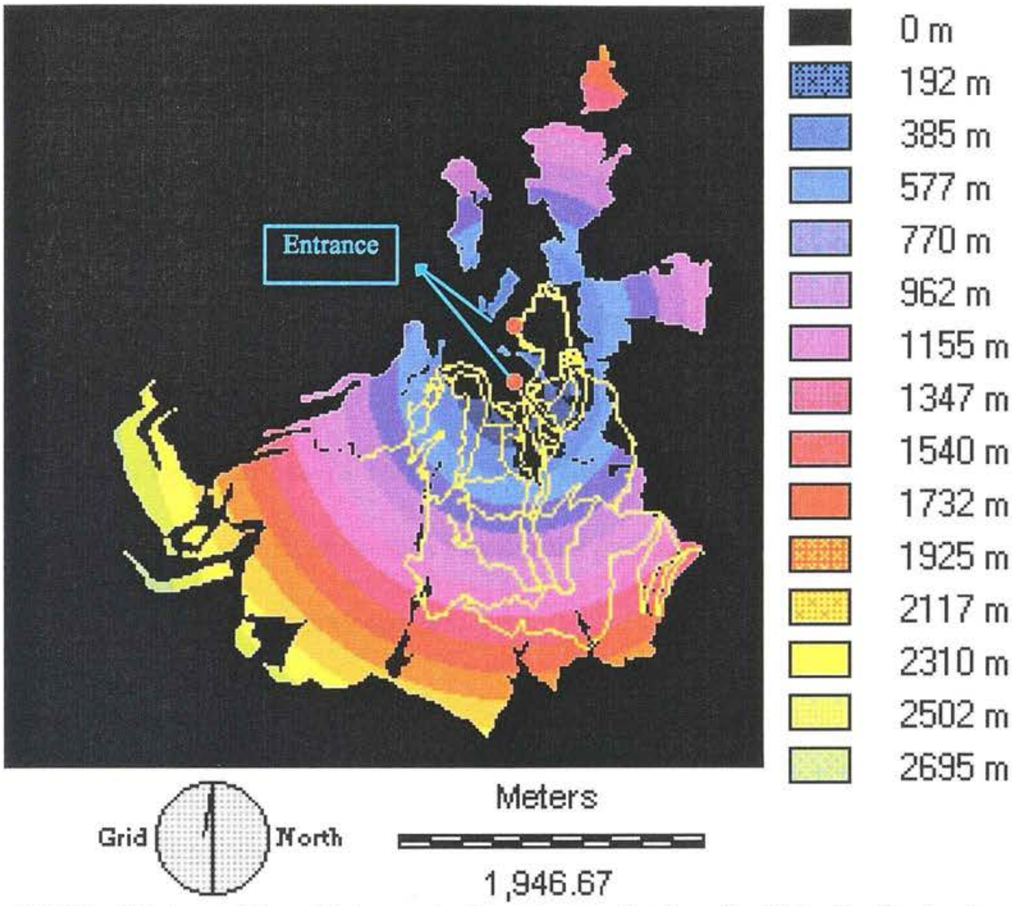


Figure 7.7 The Distance Map. Distance to the entrance (unit: m) within the Study Area.

The Distance Map was one of the Factor Maps used in the MCE evaluation for final viewpoint and path selection. As in the case of other Factor Maps, the distance was then reclassed into 256 levels (0-255) using the STRETCH technique. After reversing the values on the Distance Factor Map, the preferred closer areas were given higher values. The standardisation was then complete and available for MCE evaluation and scenario planning (Figure 7.8).

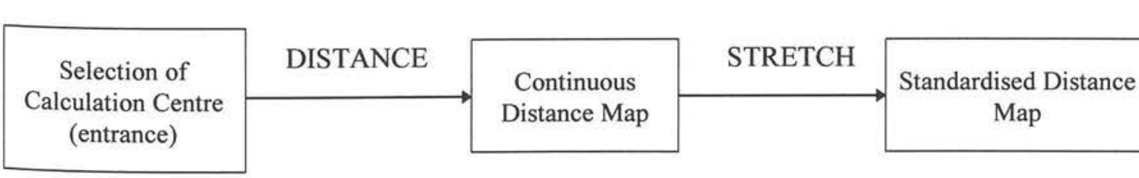


Figure 7.8 The summarised creation procedure of the Distance Map.

The two Constraint Maps are now detailed.

7.6 Environmental Sensitivity Map

Criteria including high slopes, erosionable soil, fragile geological texture and rare wildlife should be avoided when considering path development. Where development is unavoidable, care should be taken to minimise environmental impact. As previously mentioned, soil type and geology were considered as homogeneous in the Park based on the scale 1:20000 map. The steep slopes (greater than 25 degrees) and areas with high conservation value (including rare trees and frogs) were considered as Constraints and consequently had to be avoided from new viewpoint and pathway development.

7.6.1 Creation of High Slope Map

The previously mentioned Slope Map (scale 1:20000) obtained from Chitou's DTM, was used and reclassed into a Boolean image (0 or 1) using the RECLASS module. Areas in which slopes were equal or greater than 25 degrees were assigned with 0 (exclusion areas). 1 was allocated to the other areas (allowed for development). In this way, the steep areas were excluded from consideration for recreation development. The Constraint Map for steep slopes is shown in Figure 7.9.

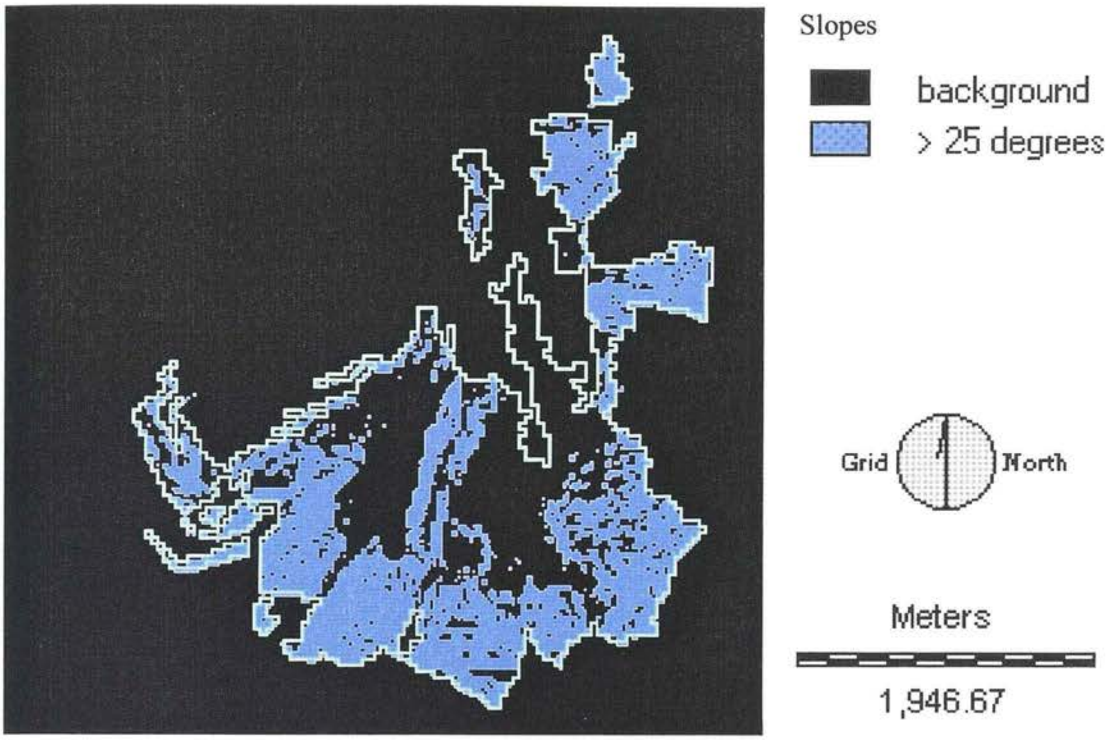


Figure 7.9 The Steep Slope Map. Slopes where are greater than 25 degrees in the Study Area.

7.6.2 Creation of Conservation Map

Rare trees require a high level of protection. Many rare frogs have only a limited habitat range compared to other wildlife such as birds. Both groups were required to be excluded from recreation development.

The Rare Tree and Frog Maps were digitised using the DISPLAY LAUNCHER function. The spatial parameters were both copied from the Current Path Map (scale 1:5000). The Frog Map was created with a 40m wide buffer zone around defined areas as were most of the other wildlife maps. However, considering the importance of rare trees, a buffer zone of 80m was added to the rare tree image (Sitoe, 1996), using the BUFFER module. Buffers were conducted before the overlaying procedure was carried out. Both maps were then combined to produce the Conservation Map (Figure 7.10).

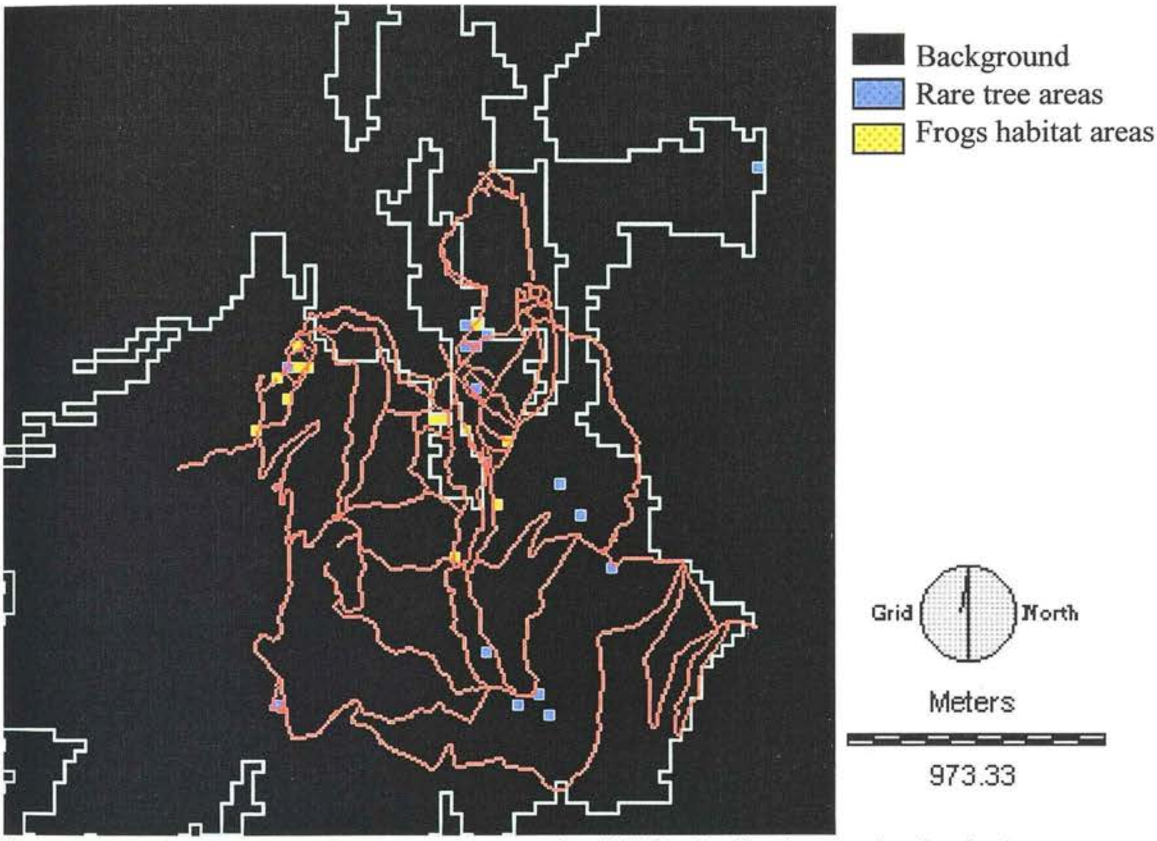


Figure 7.10 The Conservation Map. Protected wildlife distribution in the Study Area.

The Conservation Map was then ready to be reclassed into Boolean image (0 or 1; 0 means the presence of wildlife, such areas which should be excluded, and 1 illustrates areas available for development). This reclass process completed the preparation of the Conservation Constraint Map. The production procedure is shown in Figure 7.11.

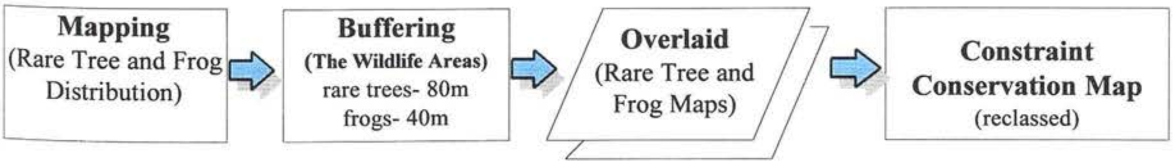


Figure 7.11 The production procedure of the Conservation Map

7.7 Scenarios Establishment and Multi-Criteria Evaluation (MCE) Application

When the choices and preparation of the criteria (Factor and Constraints Maps) were ready, the next step was to consider the relative importance of each of the 4 Factor Maps (satisfaction, recreation resources, building cost and distance). Results of the assignment will affect the choice of suitable areas for development. Three scenarios were designed based on three different considerations of the Priority of 4 Factor Maps. A set of weights for each Factor Map were assigned and with the aid of the 2 Constraint maps, the suitable development areas were identified through the MCE procedure (Figure 7.1).

7.7.1 Scenarios Establishment and Criterion Weighting

Once the standardised Factor Maps were created, the priority of the Factor Maps (scenario) had to be considered according to a specific objective prior to performing the Multi-Criteria Evaluation. A Baseline Scenario in which each factor was considered with equal priority was first established (Table 7.2). Following this two other scenarios were developed: one putting 'Satisfaction' as top priority and another putting 'Cost' as top priority. Table 7.2 presents details of all these three scenarios.

Table 7.2 Scenarios for MCE procedure and priority of the Factor Maps.

Scenarios	Name of Scenarios	Priority of Factor Maps
1	Baseline Scenario	sat = rec = cost = dis
2	Satisfaction Priority Scenario	sat > rec > cost > dis
3	Cost Priority Scenario	cost > rec > sat > dis

Key: sat- satisfaction;
rec- recreation resources;
cost- road-building cost;
dis- distance

In order to assign weights to each of the 4 Factor Maps in each scenario to reflect the factors' relative importance in the new path and viewpoint selection, the IDRISI Pairwise Comparison File (PCF) matrix was adopted. An IDRISI '9 point scale' was used for assigning the numbers for the Factor Maps' relative importance (Table 7.3).

Table 7.3 A pairwise comparison '9 point scale' as a reference basis to assign the numbers representing Factors Maps' relative importance. (Based on Saaty, 1977)

1/9	1/7	1/5	1/3	1	3	5	7	9
extremely low	very low	moderately low	slightly low	equal	slightly high	moderately high	very high	extremely high
(row less important than column)						(row more important than column)		

The Pairwise Comparison File matrixes for each of the three Scenarios were made based on their factor priority and shown in Table 7.4.

Table 7.4 Pairwise Comparison File matrixes for assigning weightings to each Factor Map.

(a) A PCF matrix for the Baseline Scenario (priority of the factors: Satisfaction = Recreation Resources = Cost = Distance).

Scenario 1	Factor 1	Factor 2	Factor 3	Factor 4
sat	1			
rec	1	1		
cost	1	1	1	
dis	1	1	1	1

Factors	Weights
sat	0.25
rec	0.25
cost	0.25
dist	0.25

(Consistency Ratio = 0.00)

(b) A PCF matrix for the Satisfaction Priority Scenario (priority of the factors: Satisfaction > Recreation Resources > Cost > Distance).

Scenario 1	Factor 1	Factor 2	Factor 3	Factor 4
sat	1			
rec	1/3	1		
cost	1/5	1/3	1	
dis	1/7	1/5	1/3	1

Factors	Weights
sat	0.57
rec	0.26
cost	0.12
dist	0.06

(Consistency Ratio = 0.04)

(c) A PCF matrix for the Cost Priority Scenario (priority of the factors: Cost > Recreation Resources > Satisfaction > Distance).

Scenario 1	Factor 1	Factor 2	Factor 3	Factor 4
cost	1			
rec	1/3	1		
sat	1/5	1/3	1	
dis	1/7	1/5	1/3	1

Factors	Weights
cost	0.57
rec	0.26
sat	0.12
dist	0.06

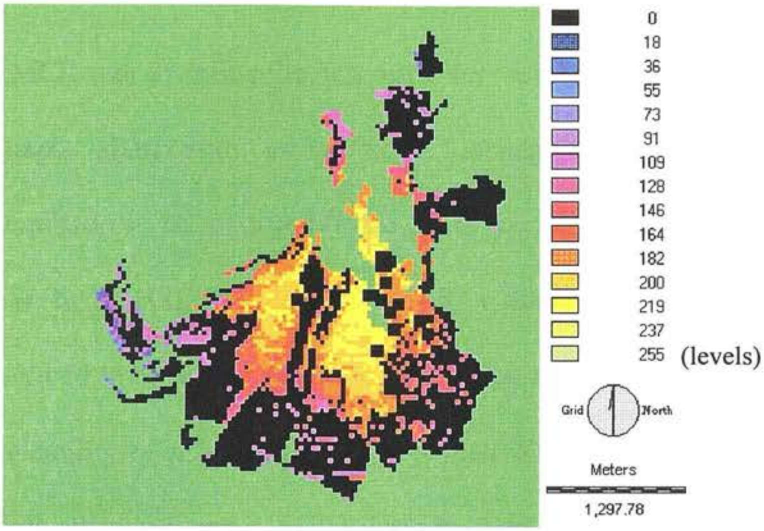
(Consistency Ratio = 0.04)

Key: sat- satisfaction;
rec- recreation resources;
cost- road-building cost;
dis- distance

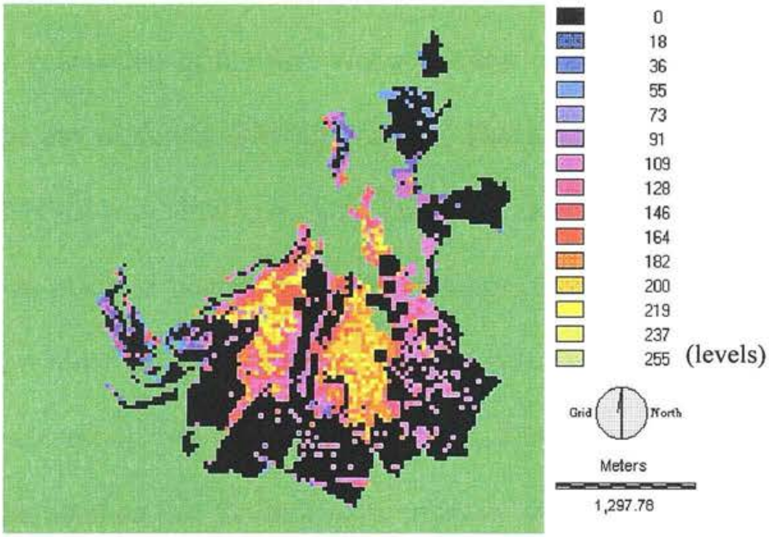
An IDRISI WEIGHT module was used to calculate a set of weights which totalled 1 for each factor in each scenario, this indicated the Factors' relative importance (Table 7.4). The construction of the Pairwise Comparison File matrix was a subjective process and the investigation of the consistency of the ranking of factors in the matrixes is therefore required. The consistency ratio of the PCF matrix was measured after the WEIGHT command was applied to test the reliability of the assigned weights. A consistency ratio of 0 is excellent, while a ratio of 1 is poor (Saaty, 1977). All consistency ratios obtained for three scenarios were less than 0.05, which is an acceptable result (Table 7.4(a)(b)(c)).

7.7.2 Multi-Criteria Evaluation and Suitable Development Area Selection

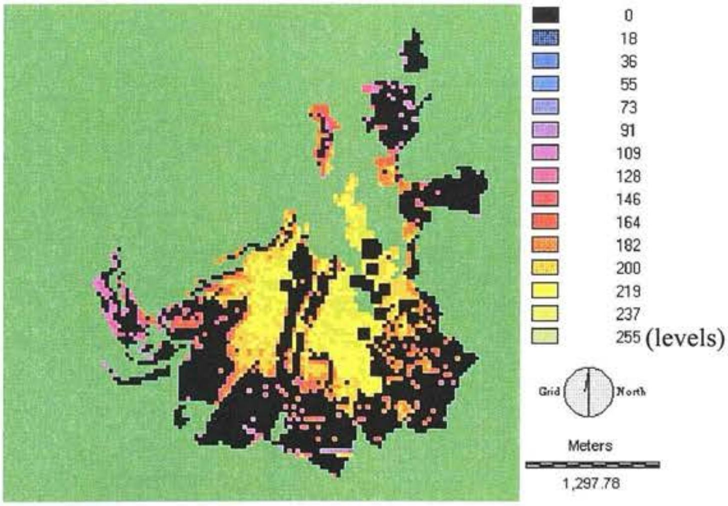
Once the weights to the 4 Factor Maps were assigned, the 4 weighted Factor Maps and two Constraint Maps (steep slopes and conservation maps) were combined to examine the suitable development areas in the Park for recreation development using the MCE process. MCE was completed by multiplying each weighted Factor Map (i.e., each raster pixel within each map) by its weight. The multiplied maps were then summed together (weighted linear combination). The resulting map had a range of values that matched the IDRISI standardised 0-255 levels. The Constraint Maps were then overlaid with the resulting map in turn in order to remove the unsuitable areas (0 zones). The Suitability Map was then developed (Figure 7.1). The final result is shown in Figure 7.12.



(a) Suitability Map 1 (where Factors and Constraints meet the Baseline Scenario 1).



(b) Suitability Map 2 (where Factors and Constraints meet the Satisfaction Priority Scenario 2).

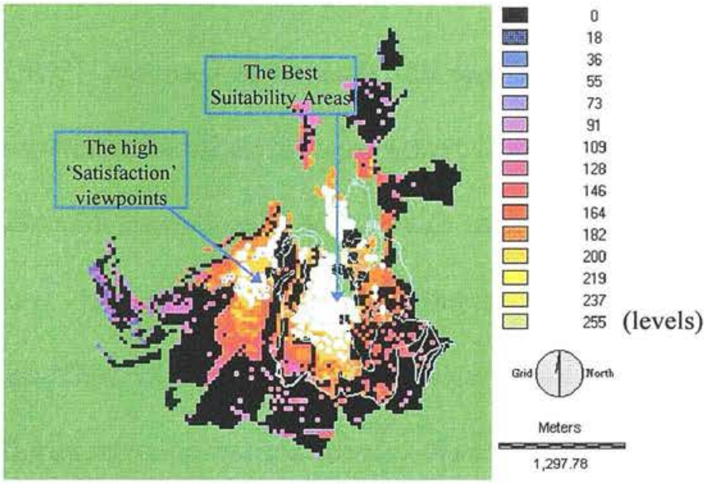


(c) Suitability Map 3 (where Factors and Constraints meet the Satisfaction Priority Scenario 3).

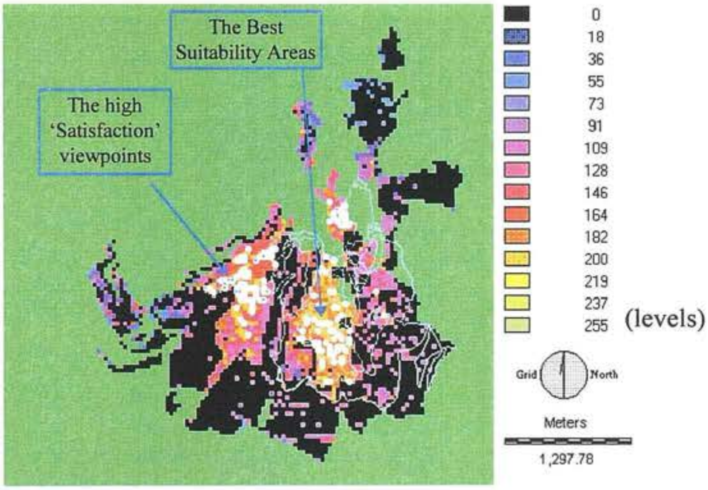
Figure 7.12 Suitability Maps based on three scenarios for recreation development selections. (attributes were standardised into 256 levels for comparison between maps. The areas with higher score are development preferred)

The final step using MCE was to define the best areas for recreation development within the three Suitability maps. Depending on different management and decision-making considerations, the standard can be modified (trade-off process) in order to filter out the best or most suitable areas. In IDRISI, the higher values in a standardised map represent those areas which are considered to be highly favoured in decision making. In this study, the areas with a rank in the Suitability Map equal to or greater than 200 were subjectively defined as the 'Best Areas', and extracted using RECLASS to meet the visitor and management demands (Figure 7.13). As shown in the best Suitability Map (Figure 7.13), each pixel already included the calculation of the four values: (i) cost of construction of the pathway, (ii) nearest to recreation resources (iii) the level of Dissatisfaction (to meet the special requirement of PATHWAY module operation, minimum ranked scores are the favourite, Dissatisfaction was in place of 'Satisfaction' for running) and (iv) the distance from start. Using these values, a route from one pixel to the next was determined using PATHWAY module towards the closest defined viewpoint. The above four values were combined to give a total score for each pixel so that the best score pathway from start point to the first new viewpoint was achieved.

(a) Baseline Scenario (which shows Best suitability areas where Factors and Constraints meet the Baseline Scenario).



(b) Satisfaction Priority Scenario (which shows Best suitability areas where Factors and Constraints meet the Satisfaction Priority Scenario)



(c) Cost Priority Scenario (which shows Best suitability areas where Factors and Constraints meet the Cost Priority Scenario)

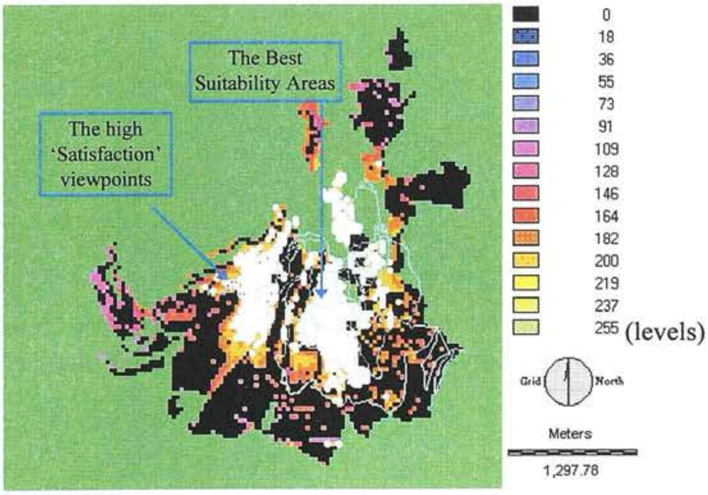


Figure 7.13 Overlay of the Best Areas (rank>=200) and potential new viewpoints for development. (White spots are best areas; Blue spots are High satisfaction areas. The production of the latter is described in the following section.) (attributes are standardised into 256 levels. The areas with higher score are development preferred)

The completion of scenario establishment was achieved in 3 steps. First, the COST DISTANCE function in IDRISI was used to generate the surface shown in Figure 7.14 blending the minimum four values and smallest distance values. Second, the Satisfaction map was used to locate the pixels with exceptionally high values (here with Satisfaction levels over 0.95). The potential new viewpoints in each scenario are shown Figure 7.13. Finally, viewpoints and the prepared 'Cost Distance Surfaces' were used for path selection. The details of viewpoint and pathway selection come in the next section.

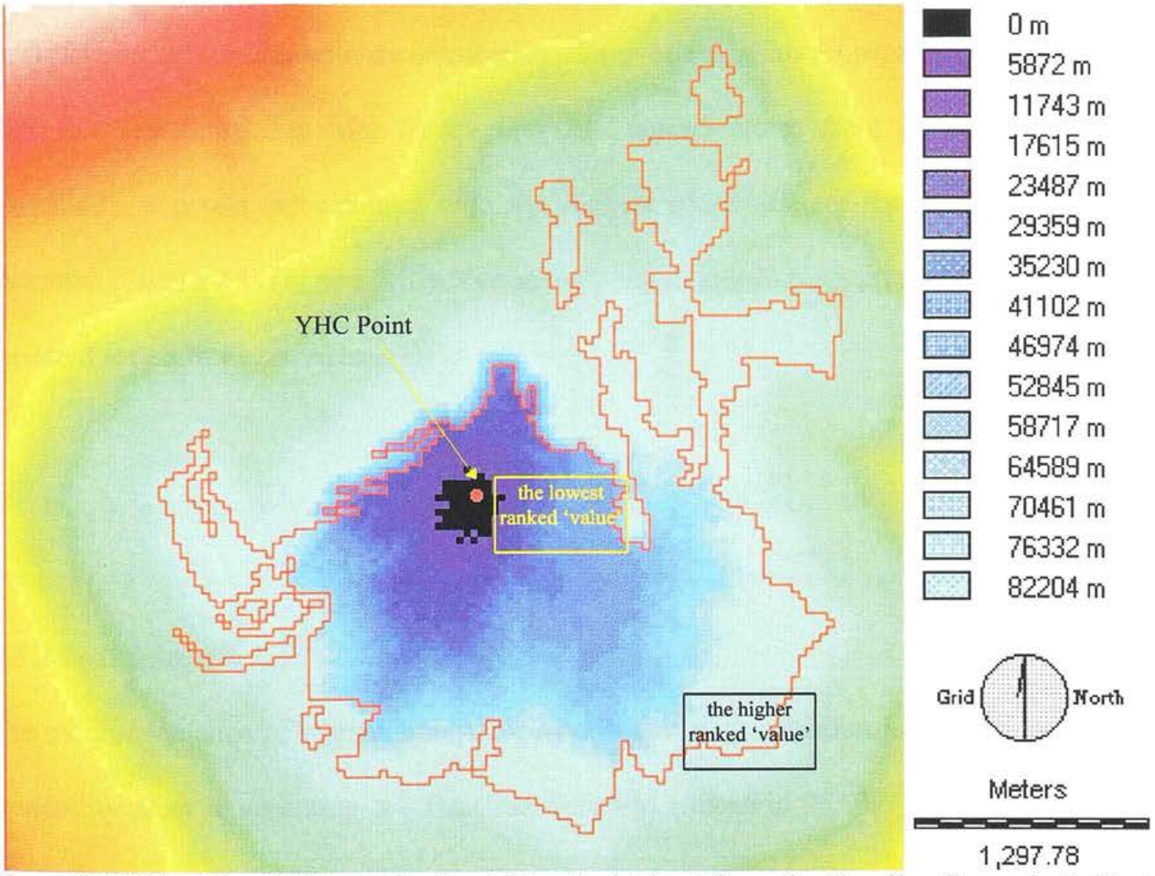


Figure 7.14 The 'Cost Distance Surface' Map 1 obtained from the Baseline Scenario 1. Cost distance (unit: m) calculated from Youth Hostel Centre (YHC) point.

7.8 Viewpoint and Path Alternatives and Selection

7.8.1 Viewpoint Selection

In order to maximise recreation enjoyment, a new pathway connected to the best viewing points and extending from the current path system was designed. The requirement of this path to link the six best viewpoints instead of one was adopted as an example in order to increase the attraction of a new pathway. In order to identify these 6 most priority viewpoints, the Satisfaction Map (with satisfaction occurrence probability ranks from 0-1 representing 0-100 percent) was reclassed and as previously mentioned the areas with rank 0.95 (95 percent) or greater were extracted. After overlaying this 95 percent Satisfaction Map with the best Suitability Map (areas > = 200 ranked scores from the 256 levels were identified), 6 pixels (viewpoints) with the highest scores among the overlay areas were extracted (Figure 7.1) (Figure 7.13). The same 'potential viewpoints prepared procedure' was repeated for all three scenarios.

7.8.2 Path Selection

For the convenience of explanation, the procedure of path selection is focused on the first Suitability Map representing the Baseline Scenario (Scenario 1), the same procedure was applied to the other two scenarios.

After the six top viewpoints in the first Suitability Map were identified, a starting point for a new pathway connecting these new points was considered. The *Youth Hostel Centre* (YHC) (location refers to Figure 1.2) is in the west side of current path network, and as mentioned previously, accommodates up to 418 persons a day during the peak season. It can be assumed therefore that this number of people each day started their visit to the Park from this point. This group of visitors consisted of 12 percent of the average daily visitors during peak season. Many other visitors also go to this location. A new pathway to help decrease crowd density from this point was therefore explored.

Once the start point of a new pathway and best viewing points were identified, two IDRISI modules including 'COST DISTANCE' and 'PATHWAY' were used in order to complete the path planning. In order to avoid confusion with the terms of 'Cost Map' or 'building cost' used in this study, the 'COST' module was re-named the 'COST DISTANCE' module, as the ranking values could have a meaning such as period of travel time, suitability extent, etc.. The 'COST DISTANCE' and 'PATHWAY' modules are introduced in the following section.

7.8.2.1 Introduction to 'COST DISTANCE' and 'PATHWAY' modules

A 'COST DISTANCE' module was run to generate a continuous concentric distance surface ('Cost Distance Surface' Map) from one or more source points to the edges of the map (Figure 7.14). These continuous distances represent the continuous 'ranked scores'. The ranked distance scores increase from the starting point(s) (the lowest 'ranked score' point). As the roads go further from the starting points, the ranked distance scores increase, and the preference decreases. The production of 'Cost Distance Surface' requires a *source map* (the Suitability Map representing the Baseline Scenario was used as *source map* in this example) as the calculation basis from which the relative ranks of each pixel was calculated (Table 7.15).

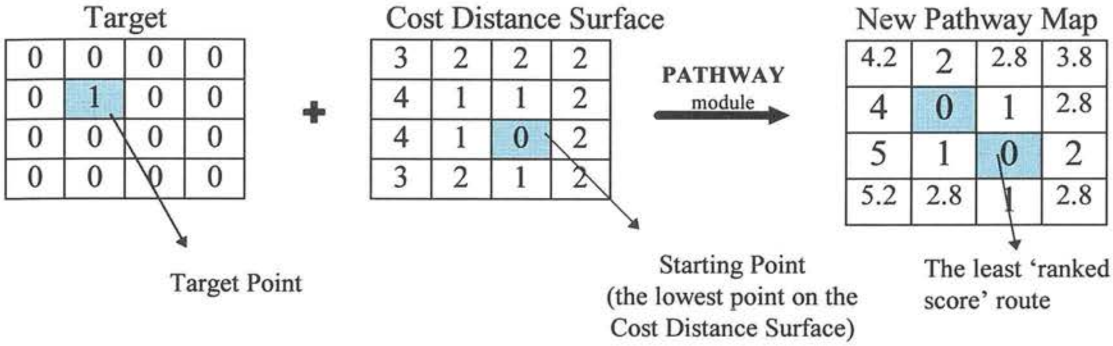


Figure 7.15 A simplified example of 'COST DISTANCE' and 'PATHWAY' operations. The two darker pixels in the New Pathway Map show the least ranked score route.

The 'PATHWAY' module investigates the least ranked route between a target(s) (new viewpoints) and the lowest 'ranked score' point on a 'Cost Distance Surface' Map. The lowest score point, the starting point(s) is centred in the lowest ranked score pixel (Figure 7.15) on the 'Cost Distance Surface' Map. Using the 'PATHWAY' module on the 'Cost Distance Surface' , the module ran from the target point to the lowest point by calculating the pixel scores on 'Cost Distance Surface' (Straight ahead obtained lower scores than diagonal way). The lowest 'ranked score' route linking the terminal point (source point) and target point was than produced by identifying the small number pixels on the resulting New Pathway Map (Figure 7.15).

7.8.2.2 Approach to Path Selection

In this study, many short paths were created (Figure 7.16), separately between points (including 6 new viewpoints, the starting point (YHC) and the defined end point (*the*

University Pond)) back on the existing path system, using both 'COST DISTANCE' and 'PATHWAY' modules. These short paths (a total of 7) were then combined together and became a new pathway.

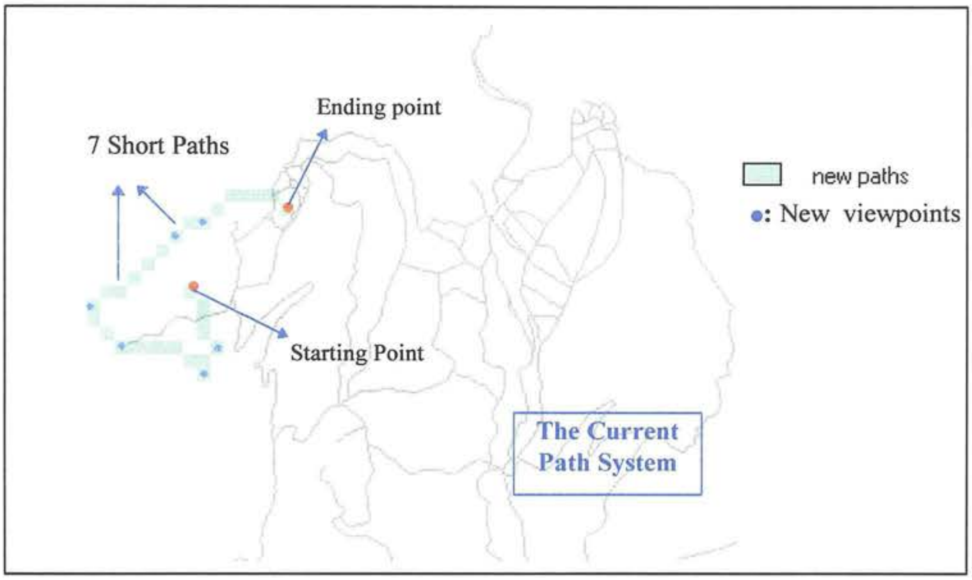


Figure 7.16 A simplified diagram of 7 linking short paths for a new long pathway and the current path system.

Before conducting the 'COST DISTANCE' module, the values on the first Suitability Map (the *source map*) were reversed again (refer Section 7.3.2) as the 'PATHWAY' module determined the least 'ranked score' route to go. The first Suitability Map was produce with the format of 256 standard levels (where high levels stand for preferred areas). After reversing, the areas with high suitable scores for development on the first Suitability Map were re-assigned with lower scores to meet the specific demands of the PATHWAY module. A short path developed using this 'PATHWAY' module was then created. The route passed through the best areas on the first Suitability Map (from the Baseline Scenario). The same procedures of COST DISTANCE and PATHWAY operations were applied to produce the remaining 6 short paths one by one (Figure 7.17).

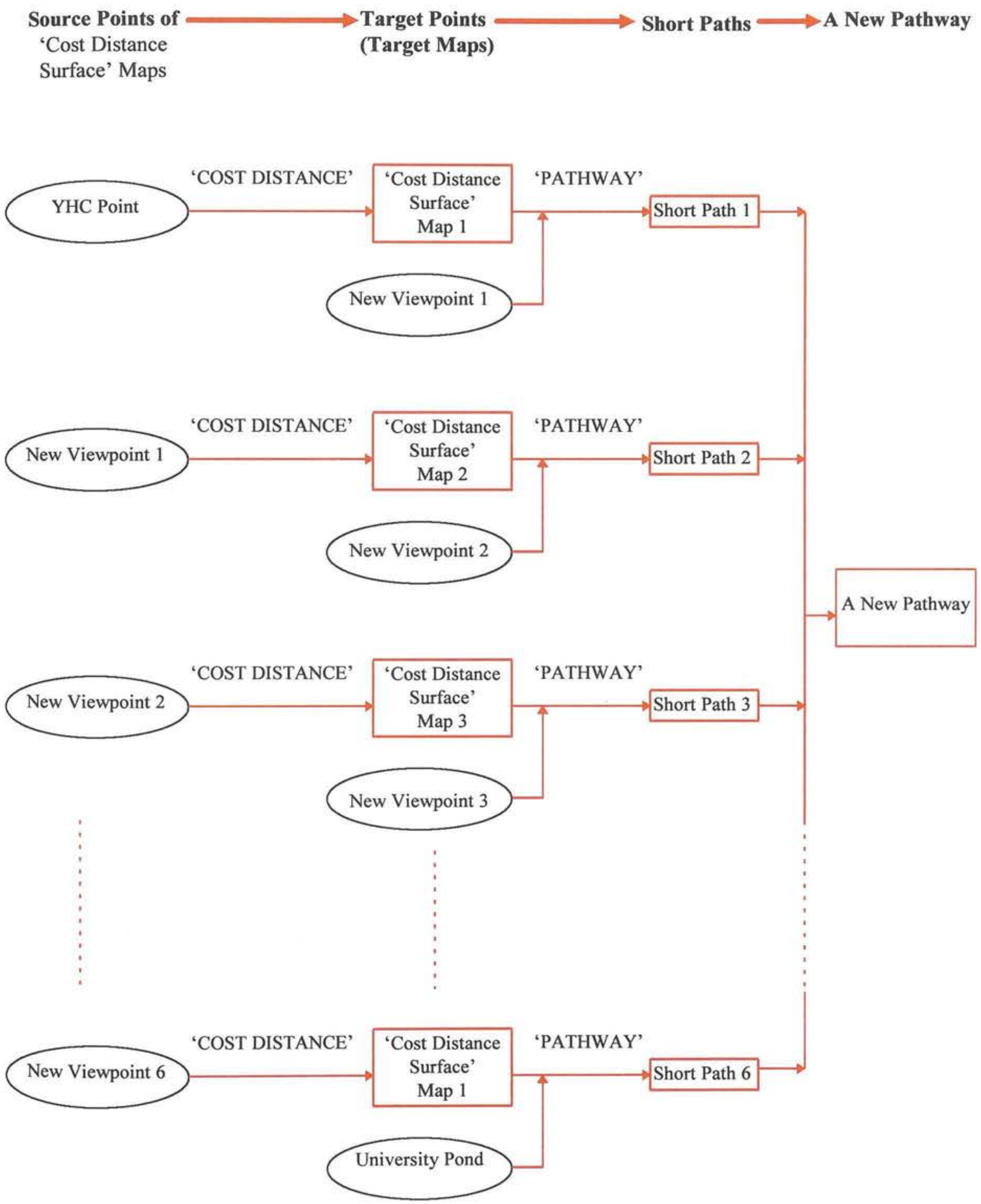


Figure 7.17 Summarised diagram of pathway production for each scenario.

Initially, the 'Cost Distance Surface' Map 1 was created by measuring the distance from the starting point (Youth Hostel Centre) on the first Suitability Map (the *source map*) using the 'COST DISTANCE' module. The starting point (YHC) was then centred to produce continuous concentric circles 'Cost Distance Surface' Map 1 (Figure 7.14 and 7.16). This point (YHC) then became the lowest 'ranked score' point (a terminal point) on this map.

The new viewpoint 1 now became the target map 1 as the process was repeated (Figure 7.17) (All 6 new viewpoints, the YHC and *University Pond* were digitised as maps using IDRISI on screen digitiser, DISPLAY LAUNCHER module, before this path selection operation.). Target map 1 was a map which indicated an end where 'PATHWAY' module running from and back to the YHC point along the short path 1 (PATHWAY runs from the target point to the 'Cost Distance Surface' centred starting point in an opposite way) (Figure 7.14). The short path 1 linking the terminal point (YHC point) and the new viewpoint 1 was then produced.

Next, the short path 2 linking the new viewpoint 1 (the new source point) and the new viewpoint 2 (the new target point) was determined using the same process. The first Suitability Map was again used as the *source map* for the new viewpoint 1 to measure a continuous concentric circle 'Cost Distance Surface' Map 2. The new viewpoint 1 then became the lowest 'value' point for the 'PATHWAY' module to identify the lowest' value' route, the short path 2, from the new viewpoint 2. The same procedure was repeated for the remaining new viewpoints and ended at the *University Pond* point (Figure 7.16) (Figure 1.2). Once the 7 short paths were created, they were combined through overlay. A new pathway selection for the Baseline Scenario was completed.

The same pathway selection procedure was applied to the Satisfaction Priority Scenario 2 and the Building Cost Priority Scenario 3. Consequently, 3 new pathways were produced, each representing one of the three scenarios. The final selection of the best scenario and the resulting new viewpoints and pathways to meet the recreation development demands will be explored in the next section.

7.8.3 Evaluation of Scenarios and Final Viewpoint and Path Selection

As previously indicated, three scenarios were designed based on different combinations of the 4 Factor maps under different decision-making scenarios. The resulting 3 new pathways from each scenario were then used to compare with the 4 Factor Maps in order to identify the best scenario.

The evaluations included two types of investigation, the investigation of Suitability Map and the investigation of the new path. In the first part, the comparison of the Suitability Map (Attributes are 256 levels based) including *'the size of Suitability Area'*, *'the size of Best Area'*, *'average pixel suitability score of Current Paths' and 'average suitability scores of New Paths'* were examined (Table 7.5).

Table 7.5 The comparison of scenarios based on the resulting Suitability Map

Scenario	*The Size of Suitability Area*	*The Size of Best Area (pixel score of Suitability Map >= 200)*	*Average pixel suitability score of Current Paths*	*Average pixel suitability score of New Paths*
Baseline Scenario (sat=rec=cost=dis)	246.4 ha	46.24 ha	141.49	184.9
Satisfaction Priority Scenario (sat>rec>cost>dis)	246.4 ha	21.92 ha	127.91	190.55
Cost Priority Scenario (cost>rec>sat>dis)	246.4 ha	104.96 ha	149.07	198.50

Key: sat- satisfaction;
rec- recreation resources;
cost- road-building cost;
dis- distance

A short description explaining how each of the three suitability scores was produced is given below:

(I) *'The Size of Suitability Area'* was calculated by measuring the areas of the three Suitability Maps.

(II) *'The Size of Best Area'* was calculated by measuring the areas of the three Best Suitability Maps *(where the pixel scores of Suitability Map > = 200)*.

(III) *'Average pixel suitability score of Current Paths'* was obtained by using the Current Path Map as the feature definition map to extract the relative attribute values from the three Suitability Maps and calculated the average.

(IV) *'Average pixel suitability score of the new paths'* was obtained by using three New Path Maps as the feature definition maps to extract the relative attribute values from the three Suitability Maps, respectively. The averages were calculated.

A high score, relates to a high suitability. As Table 7.5 shows, all three scenarios have the same size of suitability areas but the Cost Priority scenario has the best results when comparing the Best Suitability Areas (104.96 ha). In addition, each new path has higher average pixel suitability scores than the existing path in each scenario.

In the second part of comparisons, an investigation was carried out on the comparison of the three resulting new paths derived from each development scenario. *'Average length of the new paths'*, *'satisfaction of the new paths'*, *'building cost of the new paths'* and *'remoteness of the new paths to recreation resources'* were the five characteristics compared (Table 7.6).

Table 7.6 The comparison of scenarios based on the priority of the resulting new paths on 4 Factor Maps.

Scenario	*Average length of the new paths*	*Average Slopes of the new paths* (degrees)*	*Remoteness of the new paths to recreation resources*	*Satisfaction of the new paths(0-1)*
Baseline Scenario (sat=rec=cost=dis)	1200m	9.96	196.36m	0.68
Satisfaction Priority Scenario (sat>rec>cost>dis)	1240m	10.27	198.13m	0.71
Cost Priority Scenario (cost>rec>sat>dis)	1200m	9.61	194.13m	0.67

(*Average Slopes of the new paths** : stands for *Relative Building Cost of the new paths*)

Key: sat- satisfaction;
rec- recreation resources;
cost- road-building cost;
dis- distance

A short explanation showing how each of the data in each comparison issue was produced is given below:

(I) *'Average length of the new paths'* was obtained from calculating the pixels of each New Path Map and multiplying the length of pixel size (40m).

(II) *'Building cost of the new paths'* was obtained by extracting the relative attribute values of each new path from the Slope Map, respectively. The averages were calculated. The result represented in slope degrees forms for the relative cost of each scenario. The lower the slopes, the less the path-building cost.

(III) *'Distance of the new paths to recreation resources'* was obtained by extracting the relative attribute values of each new path from the same Recreation Resource Distance Map, respectively. The averages were calculated (The Recreation Resource Distance Map was produced from calculating the distance between each pixel in the Recreation Resource Map.)

(IV) '*Satisfaction of the new paths*' : The probability of satisfaction occurrence of the new paths was obtained by extracting the relative attribute values of each new path from the same Satisfaction Map, respectively. The averages were calculated. The original Satisfaction Map (the one before standardisation, ranged from 0-1, representing 0-100%) was adopted for this operation.

As shown in Table 7.6, the Cost Priority scenario again still had the best results in all comparison issues (cost, recreation resources and short) with the exception of the comparison (IV), '*Satisfaction of the new paths*'. The highest ranked value for the Satisfaction Map was from Satisfaction Priority Scenario (0.68). The average satisfaction occurrence probability of current path system was 0.26. All three new pathways (0.68, 0.71 and 0.67) had an improved 'satisfaction' extent, as a result, the new designs were considered satisfactory.

After comparing the results in Table 7.5 and Table 7.6, the Cost Priority Scenario (resulting in the Suitability Map 3) was selected as the final recreation development alternative. The new route with the 6 most favoured viewpoints from this scenario was the chosen path (Figure 7.18). This selection meets the considered objectives of low building-cost, abundant recreation resources, high satisfaction occurrence, close proximity and short in length.

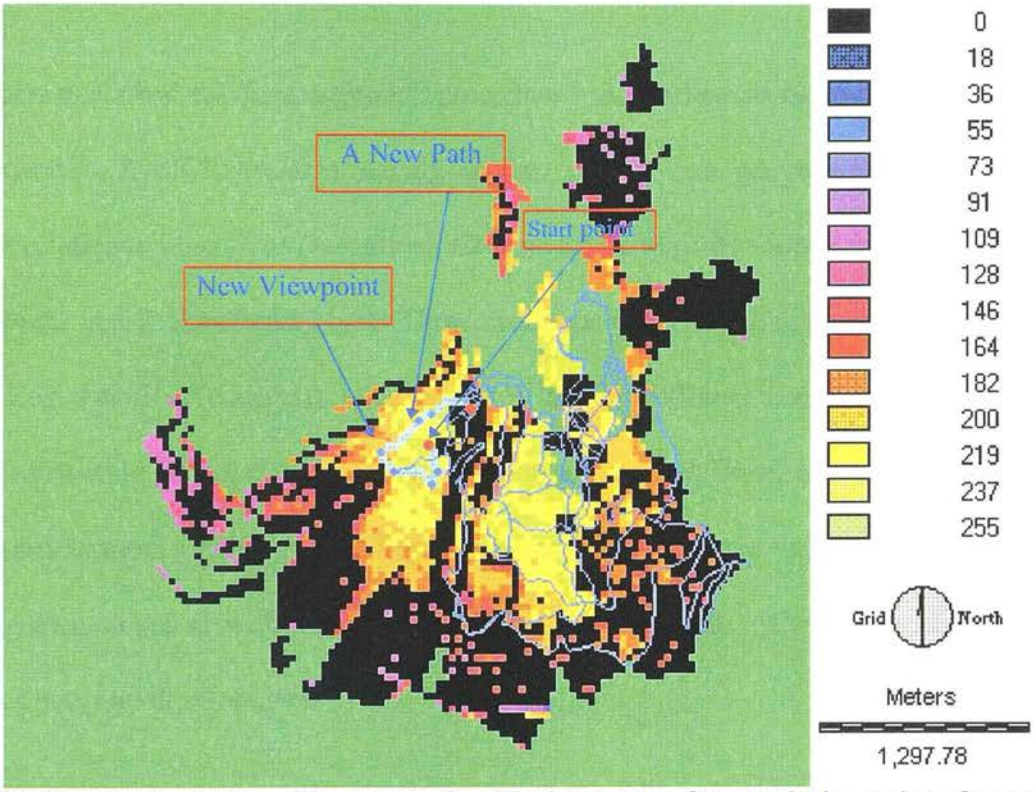


Figure 7.18 The final solution. The new path with the 6 most favoured viewpoints from the Cost Priority Scenario (the Suitability Map 3). (Attributes are standardised into 256 levels. The areas with higher values are development preferred.)

7.9 Summary

This Chapter described the final approach procedure in the selection of new viewpoint and pathway choices. A MCE decision-making support process was adopted to meet a set of specific development objectives (scenarios). Criteria Maps were developed and grouped into 4 Factor Maps and 2 Constraint Maps. Three scenarios (Baseline, Satisfaction Priority and Building Cost Priority Scenarios) were designed due to different combinations of the 4 Factors (Satisfaction, Recreation Resources, Building Cost and Distance Maps) under each specific consideration. Environmental Impact was considered in this development also. The areas with steep slopes or with the protection of wildlife constraint (Constraint Maps) were avoided for pathway development.

6 new viewpoints for each scenario were identified by filtering out from the best areas of the Suitability Map (> = score 200) and the Satisfaction Map (> 0.95). The 'COST DISTANCE' and the 'PATHWAY' modules were adopted to complete the new pathway selection.

The comparison of the resulting three new pathways from three alternative scenarios were used to examine the best development scenario to meet the management objectives of low building-cost, abundant recreation resources, high satisfaction occurrence, close proximity and short in length. The Building Cost Priority Scenario was chosen.

CHAPTER 8. DISCUSSION AND CONCLUSIONS

8.1 Discussion and Evaluation of Results- Advantages and Weaknesses

In order to explore natural and recreational resource preference and management, input data was obtained by questionnaire surveys and quantified and mapped for the recreation study. The assessment of visitor opinions offered the opportunity to objectively judge visitor preference and will help to lead the future direction of the Park recreation management. This aspect of the study is especially important as visitor welfare is an important objective of Park management. The spatial analysis of recreation satisfaction, was integrated with the questionnaire survey in an attempt to plan recreation development, and with the use of regression modelling, this target was achieved.

8.1.1 Questionnaire Survey Results

Two main problems in using questionnaire surveys were identified. These were question design and interview process. For the former, problems can be summarised as: (i) question types: some information, such as visitor 'satisfaction', would have been better examined using 'scales' or 'percentage' questions types rather than 'yes/no' questions; (ii) question number: questions could be better integrated so that the number of questions was reduced. For the 'interview process', the interviews took too long and resulted in careless answers by some visitors and some older visitors could not read, and as a result, could not be interviewed.

The 'colour photograph questions' provided a good response from visitors and seemed to increase their answering interest. In addition, using colour photographs for the landscape and colour series of questions (for example, landscape complexity colour photographs) helped to illustrate to interviewees the different types of landscape complexity better than 'text questions' could. In addition, 'photograph questions' such as 'Visitor Density' (no people/ less people/ many people), and 'the existence of a waterway and bridge', were represented well, consequently, the results showed clear preference results. It was also found however that certain photographs were not clear enough to show the themes of the photographs and caused a lack of understanding between respondents, for example, 'the Forest Type Photograph Study' (including conifer/ broad-leaved/ mixed/ bamboo) (in the first Part of the 'Landscape Component Questionnaire'). The choice of photographs was therefore a decisive factor in the success of the interviewing process.

8.1.2 Prediction Capability and Spatialisation Probability of the Recreation Preference Variables

The use of regression models successfully identified the independent variables of both 'Satisfaction' and 'Crowd Intensity'. The classification results (overall) represented 62.7 and 73.4 percent of respondents' opinions to 'Satisfaction' and 'Crowd Intensity' feeling, respectively. Such results are satisfactory. The 'Satisfaction' model was further as an input for spatial analysis as an element map for recreation development.

The independent variables entered into the 'Satisfaction' model included visitor preferences to brownness, natural forest, landscape complexity, orangeness and pure forest. All were mapped well. Some of the mappings for independent variables were simplified by using one or two representative features. For example, tree volume provided a good indicator for brownness. The lack of information relating to brownness and orangeness meant that visual data could not be gathered from the surrounding Study Area.

Because the Park is located in a sub-tropical area, seasonal changing is not as obvious as in some other areas and was not considered. If colour factors are applied to temperate areas, they may need to be modified. With respect to the mapping of landscape complexity, with the exception of tree species and recreation facilities, the inclusion of other landscape components will depend on the local environment. The Fragmentation Index was adopted in this study. Its advantages of operational convenience and ease for illustration were the reasons considered.

8.1.3 Scenario Establishment and the New Viewpoints and Pathways Evaluation

Based on different management objectives, three development scenarios were examined as an example using MCE. Results showed that the development simulations worked well. The Cost Priority Scenario was chosen as the recreation development solution. In a further comparison of the visible areas (based on the Visibility Map created by VIEWSHED operation) from each potential new pathway among the three scenarios (Table 8.1), the Cost Priority Scenario still showed the best. For future study, more scenario alternatives for different management priorities can be established for comparisons using the same method.

Table 8.1 The comparison of the visible areas from each potential new pathway among the three scenarios

Schemes	*Priority of Factors*	*Visible Area(ha)*
1	Baseline Scenario	227.13
2	Satisfaction Priority Scenario	197.03
3	Cost Priority Scenario	242.20

New viewpoint selection depends on various development considerations. In this study, the overlaying of the best areas of the 'Satisfaction' and 'Suitability' (maps) at the standards of 0.95 and pixel score 200, respectively, were used. The pathway that was produced was designed to meet the four management objectives of low building cost, abundance in ornamental wild life species along the pathway, high possibility of recreation satisfaction occurrence, and being near the entrance of the Park. The end point of the new pathway was selected as *the University Pond*, which is a popular viewpoint in the Park. In the future, an additional route may be considered to connect one of the six new viewpoints to another end point which is located in the existing path network system. This will allow a more even visitor distribution.

The validation of the development scenario is another consider factor. The probable map errors of 20m caused by digitising has to be mentioned. The examination of the development validation by the Park managers, for example, or by the experts in the Park will be helpful.

8.2 Evaluation of the Study

The main weaknesses of the methodology that was adopted in this study are examined below.

8.2.1 Problems of Questionnaire Survey Method

Any weakness in the questionnaire survey depends on the design of questionnaires as only a proper questionnaire design can obtain the information required. The simplification of question type designs would have helped the analysis. In addition, large quantities of questions should be avoided. Also, the correct choice of photographs is essential if the questionnaire is to be successful.

8.2.2 Limitation of Regression Models for Recreation Development Using GIS

The spatialisation of independent variables performed well in the mapping of the 'Satisfaction Map'. The 'Satisfaction Map' was established on the basis that visitors' Willingness To Pay had to have a positive relationship with Park satisfaction. However, the successful integration of regression modelling and GIS means that certain mapping techniques may need to be improved if selected independent variables, that do not possess spatial attributes, are to be studied. If only the independent variables with spatial characteristics are considered in the regression analysis, a decrease in the overall representation of models can be expected.

8.2.3 Limitation of WTP

The objectivity of visitor opinions was the reason of using WTP in this study. However, the limitation of WTP has to be considered. The restrictions included the sufficiency of information which had been offered to interviewees and which can affect the validity and reliability of the WTP results in natural resource allocation (Whitehead, *et al.*, 1995). In addition, as Ready, *et al.* (1995) indicated, respondents to WTP surveys may have difficulty resolving ambivalence over trade-offs between money and changes in levels of environmental amenities. This situation has to be considered here also.

8.2.4 Evaluation of Element Map Sources and Multi-Criteria Evaluation Application

Planning of new roads requires the consideration of more factors than those considered in this study. In addition, the creation of such elements of the 'Satisfaction Map', sub-element maps (including brownness, orange and complexity), were limited in the Study Area, when in fact larger areas should have be considered (visibility consideration). As the mappings in the Park were new, the information was incomplete and the mapping factors were simplified.

While the three development scenarios were designed, the Pairwise Comparison File matrix was subjectively based on the priority of the Factors in each scenario.

Although such a process may introduce bias, any such problem was identified using the IDRISI WEIGHT module, which assigns an index of consistency to the subjective assignment of Factor relative importance. All three consistency ratios were equal to or less than 0.04, and as such, the assignment of factor weightings was satisfactory.

8.3 Conclusions and Future Developments

In this study, a planning system to integrate both socio-economic studies (questionnaire survey, willingness to pay for natural resources and recreation quality values) and GIS spatial simulation analysis have been examined. The quantification and spatialisation of recreation preference was also investigated. The 'Satisfaction Map' for predicting visitor satisfaction occurrence probability was produced from Viewshed calculation and visibility analysis of preference component (including natural resources and landscape variables). The result was satisfactory. The main objectives of this recreation planning were to maximise achievement of management objectives within stated constraints, to increase recreation opportunity and quality, to release visitor congregation and maintain the minimal environmental impact. Low development cost was also considered. This objective was accomplished by using GIS to simulate the construction of new viewpoints and pathways which are located or lead through the areas while meeting management objectives. Three alternative development scenarios were designed to evaluate the best solution.

In summary, any similar study should pay particular attention to the following:

- to minimise the question types and have more 'scaling' rather than 'binary' questions for data quantification;
- to have more element maps involved in the planning system. An area that is larger than the Study Area should be included for visibility consideration. Inclusion of such an area will enhance the spatial pattern analysis capability.
- to further study the spatial application of the 'Crowd Intensity' regression model for recreation development.
- to redesign the Park's entrance or the existing path system are alternative approaches.

REFERENCES

Ackerson, V., and Fish, E. (1980). An evaluation of landscape unit. Photogrammetric Engineering & Remote Sensing, **46**, 347-358.

Agate, E. (1983). Footpaths: a practical handbook. (4th ed.). British Trust for Conservation Volunteers. pp. 1-192.

Allal, M., and Edmonds, G. A. (1977). Manual on the planning of labour-intensive road construction. Geneva: ILO. pp. 1-253.

Aronoff, S. (1989). Geographic Information system: a management perspective. Ottowa: WDL Publications. pp. 1-294.

Arthur, L. M. (1977). Predicting scenic beauty of forest environments: some empirical tests. Forest Science, **23**(2), 151-160.

Aspinall, R. J. (1995). Geographical information systems: their use for environmental management and nature conservation. Parks, **5**(1), 20-45.

Aspinall, R., and Veitch, N. (1993). Habitat mapping from satellite imagery and wildlife survey data using a Baysian modelling procedure in a GIS. Photogrammetric Engineering & Remote Sensing, **59**(4), 537-543.

Bara, T. J. (1994). GIS-based regionalization of natural landscape using derived landcover occurrence probabilities. GIS/LIS, 34-43.

Bartkowski, T. (1985). The concept of physiognomic landscape as a tool for spatial ecological planning. In VIIth International Symposium on problems of Landscape Ecological Research. Pezinok, Czechoslovakia. 21-26, October 1985, panel 1. **1**: 1.1.

Bayfield, N. G. (1979). Recovery of four montane health communities on Cairngorm, Scotland, to disturbance by trampling. Biological Conservation, **15**, 165-179.

Bayfield, N. G. (1980). Replacement of vegetation on disturbed ground near ski lifts in the Cairngorm Mountains, Scotland. Journal of Biogeography, **7**, 249-260.

Bishop, I. D., and Hull IV, R. B. (1991). Integrating technologies for visual resource management. Journal of Environmental Management, **32**, 295-312.

Bishop, I. (1992). Visualization in the natural environment: a look forward. Landscape and Urban Planning, **21**, 289-291.

Brookshire, D. S., Ives, B. C., and Schulze, W. D. (1976). The valuation of aesthetic preferences. Journal of Environmental Economics and Management, **3**, 325-346.

Brown, P. (1977). Information needs for river recreation planning and management. In Proceedings: River recreation management research symposium, USDA Forest Service General Technical Report NC-28. Minneapolis, U.S. pp. 193-201.

Brown, S., Schreier, H., Thompson, W. A., and Vertinsky, H. (1994). Linking multiple accounts with GIS as decision support system to resolve forestry/ wildlife conflicts. Journal of Environmental Management, **42**, 349-364.

Brown, T. C. (1987). Production and cost of scenic beauty: examples for a Ponderosa Pine forest. Forest Science, **33**(2), 394-410.

Brown, T. C., and Daniel, T. C. (1986). Predicting scenic beauty of timber stands. Forest Science, **32**, 471-487.

Brown, T. C., Richards, M. T., Daniel, T. C., and King, D. A. (1990). Scenic beauty and recreation value: assessing the relationship. In J. E. Vining (Ed.), Social Science and natural resource recreation management. pp. 281-299.

Brush, R. D. (1979). The attractiveness of woodlands: perceptions of forest landowners in Massachusetts. Forest Science, **25**, 495-506.

Brush, R. O. (1976). Perceived quality of scenic and recreational environments. In K. Craik & E. Zube (Eds.), Perceiving environmental quality. New York: Plenum Press.

Brush, R. O. (1979). The attractiveness of woodlands: perceptions of forest landowners in Massachusetts. Forest Science, **25**(3), 495-506.

Buhyoff, G. J., and Leuschner, W. A. (1978). Estimating psychological disutility from damaged forest stands. Forest Science, **24**, 424-432.

Buhyoff, G. J., and Miller, P. A. (1994). An AI methodology for landscape assessments. AI Application, **8**(1), 1-13.

Buhyoff, G. J., Arndt, L. K., and Propst, D. B. (1981). Interval scaling of landscape preference by direct- and indirect- measurement methods. Landscape planning, **8**, 257-267.

Buhyoff, G. J., Leuschner, W. A., and Arndt, L. K. (1980). Replication of a scenic preference function. Forest Science, **26**, 227-230.

Burden, R. F. (1972). Quantitative studies of the effect of human trampling on the vegetation as an aid to the management of seminatural areas. Journal of Applied Ecology, **9**, 225-243.

Burrough, P. A. (1991). Principles of GIS for land resources assessment. Oxford: Clarendon.

Burton, R. C. J. (1974). The recreational carrying capacity of the countryside. Keele University Library Occasional Publications No.11.

Carrol, C., and Morain, S. (1992). Defining biophysical land units for resource management. Photogrammetric Engineering & Remote Sensing, **58**, 1239-1244.

Chang, C.Y. (1987). The analysis of visitors' perceptions of crowding in recreational planning- application on Yanmingshan national park. M.Phil. thesis. The Graduate Institute of Horticulture, National Taiwan University. pp. 1-96.

Chen, C. T. (1993). The application of Geographic Information System to forest management- an illustration of nature reserve. M.Phil. thesis. The Graduate Institute of Forestry, National Chunghsing University. pp. 1-234.

Chen, J.H. (1980). Studies on the forest road systems of Chilan-Shan forest district and its utilization. M.Phil. thesis. The Graduate Institute of Forestry, National Taiwan University. pp. 1-115.

Chen, L. C. (1988). Forest recreation impact research- a case study of water pollution in Nai-Ton Forest Recreation Area. M.Phil. thesis. The Graduate Institute of Forestry, National Taiwan University. pp. 1-133.

Chen, M. A. (1991). A study on the application of photogrametry and remote sensing in the appraisal resource conservation and establishment of data system- Implementation of a three dimensional Geographic Information System for management of Chu-Yu-San Natural Reserve. M.Phil. thesis. National Chunghsing University. pp. 1-67.

Chen, S. Y. (1988). Relationship between crowding and outdoor recreation experience-a social-psychological approach. Ph.D. thesis. The Graduate Institute of Forestry, National Taiwan University. pp. 1-238.

Chen, W. C. (1989). The landscape preference of tourist in the recreation planning- illustrated with the three countries of Taipei. M.Phil. thesis. The Graduate Institute of Horticulture, National Taiwan University. pp. 1-137.

Chen, Z. E., and Chang, S. C. (1987). The geological and geomorphologic evolution history of Chitou Forest Recreation Area. Quarterly Journal of Experimental Forest, NTU, **1**(1), 63-76.

Cheng, C. C. (1992). GIS application in forest soil erosion. Quarterly Journal of Experimental Forest, NTU, **6**(3), 73-86.

Chiao, K. M., Cheng, Y. K., and Kuan, L. H. (1988). A study on the establishment of forestry resources data base of Chitou District, Experimental Forest, National Taiwan University. Remote Sensing, **9**, 1-29.

Christodoulou, M., and Nakos, G. (1990). An approach to comprehensive land use planning. Journal of Environmental Management, **31**, 39-46.

Clawson, M., and Knetsch, J. L. (1966). Economics of outdoor recreation. Washington D.C. Resources for the future, Inc.

Clayson, J. (1994). GIS as a management tool. In: GIS and access to the countryside: Geographical Information System and rights of ways. In C. Etchell (Ed.), Proceedings of a workshop held at the city discovery centre, Milton Keynes. Dept. of City and Regional Planning, University of Wales College of Cardiff: Countryside Recreation Network (CRN). 8 June 1995.

Cocklin, C., Harte, M., and Hay, J. (1990). Resource assessment for recreation and tourism: a New Zealand example. Landscape and Urban Planning, **19**, 291-303.

Countryside Comission. (1970). Countryside recreation glossary. Countryside Commission.

Countryside Commission. (1976). Footpaths for recreation: a policy statement. Countryside Commission, John Dower House, Crescent Place, Cheltenham. pp. 1-9.

Countryside Commission. (1978). Introduction to countryside recreation: a select bibliography. Countryside Commission, John Dower House, Crescent Place, Cheltenham. p.1.

Countryside Commission. (1980). Areas of outstanding natural beauty: a policy statement. Countryside Commission, John Dower House, Crescent Place, Cheltenham. pp. 1-11.

Countryside Commission. (1985). Cannock chase country park project: Technical Report No. 3, Encouraging visitor redistribution. Cheltenham, U.K. CCP 184.

Craik, K. (1976). Perceiving Environmental Quality. Plenum Press, New York.

Craik, K. H. (1975). Individual variations in landscape description. In E. H. Zube, R. O. Brush, & J. G. Fabos (Eds.), Landscape assessment: values, perception and resources. Dowden, Hutchinson & Ross, Inc. pp. 130-145.

Curry, N. (1987). Recreation cost-benefit analysis and the equality effect. Journal of Environmental Management, **25**, 363-375.

Daniel, T. C., and Boster, R. S. (1976). Measuring landscape aesthetics- the scenic beauty estimation method. U.S. United States Department of Agriculture Forest Service Research Paper. RM-167.

Daniel, T. C., and Schroeder, H. W. (1979). Scenic beauty estimation model: Predicting perceived beauty of forest landscapes. U.S. United States Department of Agriculture Forest Service G.T.R. PSW- 35. pp. 514-523.

Dent, J. B., and McGregor, M. (1994). Rural and farming systems analysis: European perspectives. Wallingford: CAB International. pp. 1-361.

Desbarats, J. (1983). Spatial choice and constrains on behavior. Annals of the Association of American Geographers, **73**, 340-357.

Drake, L. (1992). The non-market value of the Swedish agricultural landscape. European Review of Agricultural Economics, **19**, 351-364.

Dubgaard, A., Bateman, I., and Merlo, M. (1994). Valuing recreation benefits from the Mols Bjerge area, Denmark. Economic valuation of benefits from countryside stewardship. Proceedings of a workshop organized by the Commission of the

European Communities Directorate General for Agriculture, Brussels, 7-8 June 1993. pp. 145-163.

Duncan, J. (1978). The social construction of unreality: an interactionalist approach to the tourist's cognition of environment. In D. Ley & M. Samuels (Eds.), Humanistic geography: problems and prospects. Chicago: Maaroufa Press.

Eastman, J. R. (1992). IDRISI technical reference Version 4.0. Worcester, Massachusetts, USA: Clark University, Graduate School of Geography. pp. 130-131.

Eastman, J. R., and Gold, S. (1995). Spatial information systems and assessment of the impacts of sea level rise. In Hanoi, Vietnam: United Nations Institute for Training and Research.

Eastman, J. R., and Jiang, H. (1996). Fuzzy measures in multi-criteria evaluation. IDRISI Project, Clark University, USA. pp. 1-10.

Edwards-Jones, G., Edwards-Jones, E. S., and Mitchell, K. (1995). A comparison of contingent valuation methodology and ecological assessment as techniques for incorporating ecological goods into land-use decisions. Journal of Environmental Planning and Management, **38**(2), 215-230.

Eleftheriadis, N., and Tsalikidis, I. (1990). Coastal pine forest landscapes: modelling scenic beauty for forest management. Journal of Environmental Management, **30**, 47-62.

Etchell, C. (1994). GIS and access to the countryside: Geographical Information System and rights of ways. Proceedings of a workshop held at the city discovery centre, Milton Keynes. In Dept. of City and Regional Planning, University of Wales College of Cardiff: Countryside Recreation Network (CRN). 8 June 1995, pp. 1-43.

FAO. (1974). Logging and log transportation in tropical high forest, a manual production and costs. FAO Forestry Department Paper 18. Rome, Italy. pp. 1-90.

Fisher, P. F. (1992). First experiments in viewshed uncertainty: simulating fuzzy viewsheds. Photogrammetric Engineering & Remote Sensing, **58**(3), 345-352.

Fox, J., Kanter, R., Yarnasarn, S., Ekasingh, M., and Jones, R. (1994). Farmer decision making and spatial variables in Northern Thailand. Environmental Management, **18**(3), 391-399.

Gilbert, L. (1994). Wildlife and fisheries management. Proceedings of the 1994 Northeastern Recreation Research Symposium. General Technical Report Northeastern Forest Experiment Station: USDA Forest Service. pp. 35-50.

Glyptis, S. (1991). Countryside recreation. Longman, U.K. pp. 148-152.

Goldsmith, F. B. (1983). Ecological effects of visitors and the restoration of damaged areas. in Warren, A. and Goldsmith, F.B. (ed.) Conservation in perspective. London: Wiley. pp. 201-214.

Grime, J. P. (1973). Control of species density in herbaceous vegetation. Journal of Environmental Management, **1**, 151-167.

Haines-Young, R., Green, D. R., and Cousins, S. H. (1993). Landscape ecology and GIS. U.K. Taylor & Francis Ltd. pp. 1-281.

Harrison, C. (1981). Recovery of lowland grassland and heathland in southern England from disturbance by seasonal trampling. Biological Conservation, **19**, 119-130.

Hickin, B. W., Maguire, D. J., and Strachan, A. J. (1991). Introduction to GIS: The ARC/INFO method. U.K. Academic Support for Spatial Information Systems, Midlands Regional Research Laboratory, University of Leicester.

Ho, C. P. (1977). Analysis of artificial forest soil characteristics in the Experiment Forest of National Taiwan University of Chitou. National Taiwan University;

Hogan, J. D. (1973). Using computers in forest road location and design. Canadian Forest Industries, **93**(7), 34-37.

Holl, K. D., Daily, G. C., and Ehrlich, P. R. (1996). Knowledge and perceptions in Costa Rica regarding environment, population, and biodiversity issues. Conservation Biology, **9**(6), 1548-1558.

Holmes, T. P., and Kramer, R. A. (1995). An independent sample test of yea-saying and starting point bias in dichotomous-choice contingent valuation. Journal of Environmental Economics and Management, **29**(1), 121-132.

Howard, A. F. (1991). A critical look at multiple criteria decision making techniques with reference to forestry applications. Canadian Journal of Forest Research, **21**, 1649-1659.

Huang, M. J. (1989). Emotional experience of visitors to nature environment- a case study of visitors in Chitou Forest Recreation Area. M.Phil. thesis. Graduate Institute of Forestry, National Taiwan University. pp. 1-89.

Huang, Y. T. (1989). The management of scenic area. The Experimental Forest of National Taiwan University, Taiwan, R.O.C. pp. 1-28.

Huang, Y. T., and Liu, J. Y. (1987). The management achievements of Chitou Forest Recreation Area in the Experimental Forest of National Taiwan University. Quarterly Journal of Experimental Forest, NTU, **1**(2), 31-62.

Hull, B. R. (1989). Interpreting scenic beauty estimates. Landscape Journal, **8**, 24-27.

Hull, B. R., and Buhyoff, G. J. (1986). The scenic beauty temporal distribution method: an attempt to make scenic beauty assessments compatible with forest planning efforts. Forest Science, **32**(2), 271-286.

Hull, B. R., Buhyoff, G. J., and Daniel, T. C. (1984). Measurement of scenic beauty: the law of comparative judgment and scenic beauty estimation procedures. Forest Science, **30**(4), 1084-1098.

Hyberg, B. T. (1987). Multiattribute decision theory and forest management: A discussion and application. Forest Science, **33**, 835-845.

Ittelson, W. (1974). An introduction to environmental psychology. New York: Holt, Rinehart and Winston.

Ittersum, G. v., and Kwakernaak, C. (1977). Gevolgen van de recreatie voor het natuurlijk milieu. In Eilanden onder de voet. Werkgroep Recreatie van de landelijke Vereniging tot Behoud van de Waddenzee. Harlingen. pp. 59-103.

Jones, D., Cocklin, C., and Cutting, M. (1995). Institutional and landowner perspectives on wetland management in New Zealand. Journal of Environmental Management, **45**, 143-161.

Kangas, J. (1992). Choosing the reforestation chain in a forest stand: a decision model based on multiattribute utility theory. University of Joensuu. Publications in Sciences **24**, 1-230. (In Finnish with English summary).

Kangas, J. (1993). A multi-attribute preference model for evaluating the reforestation chain alternatives of a forest stand. Forest Ecological and Management, **59**, 271-288.

Kangas, J., Laasonen, L., and Pukkala, T. (1993). A method for estimating forest landowner's landscape preferences. Scandinavian Journal of Forest Research, **8**(408), 417.

Kaplan, R. (1975). Some methods and strategies in the prediction of preference. In E. H. Zube, R. O. Brush, & J. G. Fabos (Eds.), Landscape assessment: values, perceptions and resources. Dowden, Hutchison & Ross, Inc. pp. 118-129.

Kaplan, S. (1975). An informal model for the prediction of preference. In E. H. Zube, R. O. Brush, & J. G. Fabos (Eds.), Landscape assessment: values, perceptions and resources. Dowden, Hutchinson & Ross, Inc. pp. 92-101.

Keith, J. E., Fawson, C., and Johnson, V. (1996). Preservation or use. A contingent valuation study of wilderness designation in Utah. Ecological Economics Amsterdam, **18**(3), 207-214.

Kim, S. I. (1990). Introduction of using Geographic Information System (GIS) for forest recreation planning. Journal of Korean Forest Society, **79**(2), 205-215.

Kliskey, A. D. (1994). A comparative analysis of approaches to wilderness perception mapping. Journal of Environmental Management, **41**, 199-236.

Kliskey, A. D. (1994). Mapping multiple perceptions of wilderness in southern New Zealand, II: an alternative multivariate approach. Applied Geography, **14**, 308-326.

Kliskey, A. D., and Kearsley, G. W. (1993). Mapping multiple perceptions of wilderness in southern New Zealand. Applied Geography, **13**, 203-223.

Kobayashi, H., and Nitami, T. (1992). Forest-road network planning for mobile tower-yarder in small scale mountain forest. In: Whyte, A.G.D. & Allen, J.C. (eds.). A compendium of papers to be presented at IUFRO S3.04.01 conference, Christchurch, 27-31, New Zealand School of Forestry, University of Canterbury. January, 1992, pp. 147-154.

Kooten, G. v., Wohl, J., Ells, A., and Van, K. G. (1996). Fuzzy measures for a fuzzy concept: a new approach to nonmarket valuation. Agrarokonomische Diskussionsbeitrage Universitat Giessen, **35**, 1-27.

Kuo, P. C. (1958). The cover plants of Cryptomeria stand at Chitou Tract. Experimental Forest of National Taiwan University, **18**, 1-17.

LaGro, J. A. J., and DeGloria, S. D. (1992). Land use dynamics within an urbanizing non-metropolitan county in New York State (USA). Landscape Ecology, **7**(4), 275-289.

Lee, K. J. (1991). The economic impact of recreation resources development- a case study of Lu-Ku region. Quarterly Journal of Chinese Forest, **24**(1), 3-25.

Leon, C. J. (1996). Doubled bounded survival values for preserving the landscape of natural parks. Journal of Environmental Management, **46**(2), 103-118.

Lesslie, R. G. (1991). Wilderness survey and evaluation in Australia. Australian Geographer, **22**(1), 35-43.

Lesslie, R. G., Mackey, B. G., and Preece, K. M. (1988). A computer-based method of wilderness evaluation. Environmental Conservation, **15**(3), 225-232.

Liddle, M. J. (1975). A selective review of the ecological effects of human trampling on natural ecosystems. Biological Conservation, **8**, 251-255.

Liddle, M. J. (1975). A theoretical relationship between primary productivity of vegetation and its ability to tolerate trampling. Biological Conservation, **8**, 251-255.

Liddle, M. J., and Greig-Smith. (1974). A survey of tracks and paths in a sand dune ecosystem. 1. Soils. Journal of Applied Ecology, **12**, 893-909.

Liddle, M. J., and Greig-Smith. (1975). A survey of tacks and paths in a sand dune ecosystem. 2. Vegetation. Journal of Applied Ecology, **18**, 559-569.

Liddle, M. J., and Hylgaard, T. (1981). The effect of human trampling on a sand dune ecosystem fominated by *Empetrum nigrum*. Journal of Applied Ecology, **18**, 559-569.

Lin, C. C. (1986). Study on forest recreation resource management- a case study on national forest administrated by TFB. M.Phil thesis. The Graduate Institute of Forestry, National Taiwan University. pp. 1-157.

Lin, C. T., Chou, L. S., and Lin, Y. S. (1992). The butterfly fauna at Chi-tou Forest Recreation Area. Quarterly Journal of Experimental Forest, NTU, **6**(3), 49-66.

Lin, Y. S., and Chou, L. S. (1992). Study on the vertebrate fauna at Chitou, Taiwan. Quarterly Journal of Chinese Forest, **25**(3), 15-35.

Lindsay, J. (1980). Trends in outdoor recreation activity conflicts. In Proceedings: 1980 National outdoor recreation trends symposium, **1**. USDA Forest Service: Broomall. pp. 215-221.

Liu, J. Y. (1989). Ecological impacts of outdoor recreation and their management. Journal of Outdoor Recreation Study, **2**(1), 3-18.

Liu, J. Y. (1990). Recreation resource impacts and their management. Quarterly Journal of Experimental Forest, NTU, **4**(2), 161-172.

Liu, J. Y., and Huang, Y. T. (1989). Studies of visitor impacts on environment of Chitou Forest Recreation Area. Quarterly Journal of Experimental Forest, NTU, **3**(2), 33-51.

Liu, J. Y., Huang, Y. T., and Lu, C. C. (1984). Studies on the visitor activities and recreational demands of Chitou Forest Recreation Area. The experimental Forest of National Taiwan University. **156**, 1-26.

Liu, T. S. (1970). A list of orchids of Chitou. Monthly Notes of NTU Experimental Forest. Taiwan: The Experimental Forest of National Taiwan University. **35**: 8-9.

Liu, T. S. (1973). A preliminary report on the vegetation and flora of the Chitou Tract Experimental Forest, National Taiwan University.

Liu, T. S., Liao, J. C., Lu, T. S., and Leou, C. S. (1972). Vascular plants of the Experimental Forest, N.T.U. The Experimental Forest of National Taiwan University. **54**, 1-16.

Lockwood, M., Tracey, P., and Klomp, N. (1996). Analysing conflict between cultural heritage and nature conservation in the Australian Alps: a CVM approach. Journal of Environmental Planning and Management, **39**(3), 357-370.

Loomis, J. B., and White, D. S. (1996). Economic benefits of rare and endangered species: summary and meta-analysis. Ecological Economics Amsterdam, **18**(3), 197-206.

Lou, S. L., and Feng, F. L. (1983). Investigation and analysis of forest recreation resources in Taiwan. National Chung-Hsing University, Taiwan.

Lucas, O. W. R. (1991). The design of the forest landscapes. Oxford: Oxford University Press. pp. 1-381.

Lucas, R. (1985). The management of recreational visitors in wilderness areas in the United States. In The ecological impacts of outdoor recreation on mountain areas in Europe and North America (Edited by N.G. Bayfield and G.C. Barrow). RERG-Report, Recreation Ecology Research Group, UK. 1985, No. 9, pp. 122-136.

Maguire, D. J., Goodchild, M. F., and Rhind, D. W. (1991). Geographical Information Systems. London: Longman. pp. 4-5.

Martin, D. (1996). Geographic Information Systems: socioeconomic applications. (2nd ed.). London: Routledge.

Mathieson, A., and Wall, G. (1982). Tourism- economic, physical and social impacts. London: Longman.

McGregor, M., Willock, J., Dent, J. B., DeGloria, S. D., Sutherland, A., Gibson, G., Morgan, O., and Grieve, B. (1996). Links between psychological factors and farmer decision making. Farm Management, **9**(5), 228-239.

McKendry, J. E., Eastman, J. R., St.Martin, K., and Fulk, M. A. (1992). Analyzing deforestation and soil loss in Northern Thailand. In Explorations in Geographic Information Systems technology: applications in forestry. U.S. UNITAR European Office, Clark University, Graduate School of Geography. pp. 87-108.

Mead, R., Curnow, R. N., and Hasted, A. M. (1993). Statistical methods in agriculture and experimental biology. (2nd ed.). London: Chapman & Hall. pp.149-150.

Mercer, E., Kramer, R., and Sharma, N. (1995). Rain forest tourism- estimating the benefits of tourism development in a new national park in Madagascar. Journal of Forest Economics, **1**(2), 239-269.

Monmonier, M. S. (1974). Measures of pattern complexity for choroplethic maps. The American Cartographer, **1**(2), 159-169.

Morgan, O., Gibson, G., Willock, J., Sutherland, A., Deary, I., McGregor, M., Dent, J. B., Grieve, R., Beer, G., Huirne, R. B. M., and Pruise, H. C. (1996). The use of Cluster analysis to develop a taxonomy of farmers based on the Edinburgh study of decision making on farms. Farmers in small-scale and large-scale farming in a new perspective: objectives, decision making and information requirements. Onderzoekverslag-landbouw-Economisch-Instituut. pp. 86-96.

Morofsky, E. (1977). Sensitivity ratings as a guide in locating and evaluating transportation routes and corridors. Forest Management Institute Information Report FMR-X-101. Ottawa, Ontario. pp.1-70.

Mortimer, R., Sharp, B., and Craig, J. (1996). Assessing the conservation value of New Zealand's offshore islands. Conservation Biology, **10**(1), 25-29.

Nelson, R. R. (1984). Quantitative methods for investigating the variables that underlie preference for landscape scenes: comment No.1. Canadian Geographer, **28**(3), 284-285.

Neyland, M. G., and Brown, M. G. (1994). Disturbance of cool temperate rain forest patches in eastern Tasmania. Australian Forestry, **57**(1), 1-10.

Nieuwenhuis, M. A. (1986). Development of a forest road location procedure as an integral part of a map based information system. University of Maine. University Microfilms International, Ann Arbor, Michigan. pp. 1-193.

Norušis, M. J. (1993). SPSS 6.1 Guide to Data Analysis. Englewood Cliffs, New Jersey: Prentice Hall. pp.1-582.

Norušis, M. J. (1993). SPSS for Windows: advanced statistics, release 6.0. SPSS Inc. pp. 1-578.

Norušis, M. J. (1993). SPSS for Windows: professional statistics. Release 6.0. SPSS Inc.

Pearce, D. W., and Turner, R. K. (1990). Economics of natural resources and the environment. Harvester Wheatsheaf. pp. 1-378.

Pearce, S. R., and Waters, N. M. (1984). Quantitative methods for investigating the variables that underlie preference for landscape scenes: reply. Canadian Geographer, **28**(3), 288-290.

Pearson, R. M. (1961). The terminology of recreational geography: In Papers of the Michigan Academy of Science, Arts and Letters. Vol. XLVII, 1962. pp. 447-451.

Phipps, M. (1981). Entropy and Community pattern analysis. Journal of Theoretical Biology, **93**, 253-273.

Pigram, J. (1985). Outdoor recreation and resource management. (2nd ed.). London: Croom Helm Ltd: St. Martin's Press. pp. 1-266.

Pradham, P., and Tripathi, R. S. (1983). Competition between *Triplium repens* and *Paspalum dilatatum* as related to trampling. Acta Oecologica, **4**(4), 345-353.

Pruckner, G. J. (1995). Agricultural landscape cultivation in Austria: an application of the CVM. European Review of Agricultural Economics, **22**(2), 173-190.

Pukkala, T., Kellomäki, S., and Mustonen, E. (1988). Prediction of the amenity of a tree stand. Scandinavian Journal of Forest Research, **3**, 533-544.

Rasmussen, W. O. (1991). Dynamic visibility in a forested environment for resource planning and management. Journal of Environmental Management, **33**, 365-377.

Ready, R. C., Whitehead, J. C., and Blomquist, G. C. (1995). Contingent valuation when respondents are ambivalent. Journal of Environmental Economics and Management, **29**(2), 181-196.

Roggenbuck, J. W., Williams, D. R., and Watson, A. E. (1993). Defining acceptable conditions in wilderness. Environmental Management, **17**, 187-197.

Rollins, K., Wistowsky, W., and Jay, M. (1995). Wilderness canoeing in Ontario: using cumulative results to update dichotomous choice contingent valuation offer amounts. Working Paper Department of Agricultural Economics and Business: University of Guelph. DP95-03. pp. 1-22.

Ruemler, R. E. (1988). Techniques of environmental impact assessment, with special reference to road planning. In P. McGowan (Ed.), Landscape under stress. The papers of the Landscape Institute Annual Conference 1987. The Landscape Institute, Scotland. University of St. Andrews, U.K. pp. 25-42.

Rummel, R. J. (1970). Applied factor analysis. Evanston: Northwestern University Press. pp. 356-363.

Saaty, T. L. (1977). A scaling method for priorities in hierarchical structures. Journal of Mathematics Psychology, **15**, 234-281.

Sakai, T. (1983). Studies on planning method of forest roads network (II) - Evaluation by skidding distance and road length for optimum network. (Japanese with English summary). Bulletin of the Kyoto University Forestry 55. pp. 222-229.

Schneider, K., and Robbins, P. (1995). Spatial relationships between ecosystems and topography: modelling landscape ecology. In K. Schneider & P. Robbins (Eds.), Explorations in Geographic Information Systems technology: GIS and mountain environments. pp. Exer 6: 1-19. U.S. UNITAR European Office, Clark University, Graduate School of Geography.

Schroeder, H. W., and Orland, B. (1994). Viewer preference for spatial arrangement of park trees: an application of video-Imaging Technology. Environmental Management, **18**(1), 119-128.

Selman, P. (1992). An investigation of the potential for landscape ecology to act as a basis for rural land use plans. Journal of Environmental Management, **35**, 281-299.

Selman, P. (1992). Environmental Planning: The conservation and development of biophysical resources. London: Paul Chapman Publishing Ltd. pp.1-195.

Shafer, E. L., Hamilton, J. F., and Schmidt, E. A. (1969). Natural landscape preferences: a predictive model. Journal of Leisure Research, **1**, 1-19.

Sitoe, A. A. (1996). Structure and composition of a natural forest in the Manica region, Mozambique and their implication to the management of local forests. Whydah Newsletter, **5**(2), 10-12.

Smith, C. L., Steel, B. S., List, P. C., and Cordray, S. (1995). Making forest policy: integrating GIS with social processes. Journal of Forestry, May, 31-35.

Smith, I. R. (1988). Ecology and design. Journal of Environmental Management, **26**, 103-109.

Sowman, M. R. (1987). A procedure for assessing recreational carrying capacity of coastal resort areas. Landscape and Urban Planning, **14**, 331-344.

Stankey, G. H., and McCool, S. F. (1989). Beyond social carrying capacity. In Jackson, E. L. and Burton, T. L.(eds) Understanding leisure and recreation. Venture Publishing Pennsylvania. pp. 497-516.

Storms, D. M., Davis, F. W., and Cogan, C. B. (1992). Sensitivity of wildlife habitat models to uncertainties in GIS data. Photogrammetric Engineering & Remote Sensing, **58**(6), 843-850.

Tan, J. (1992). Planning a forest road network by a spatial data handling- network routing system. Acta Forestalia Fennica, **227**, 1-85.

The Experimental Forest of National Taiwan University. (1979). Common plants of Chitou Forest Recreation Area. The Experimental Forest of National Taiwan University.

The Experimental Forest of National Taiwan University. (1980). Bamboos of the Chitou Forest Recreation Area. The Experimental Forest of National Taiwan University. pp. 1-158.

The Experimental Forest of National Taiwan University. (1993). Introduction of the experimental forest, College of Agriculture, National Taiwan University. The Experimental Forest of National Taiwan University.

Thurmond, D. P., Miller, K. V., and Harris, T. G. (1995). Effect of streamside management zone width on avifauna communities. Southern Journal of Applied Forestry, **19**(4), 166-169.

Tips, W. E. J., and Savasdisara, T. (1986). Landscape preference evaluation and sociocultural background: a comparison among Asian countries. Journal of Environmental Management, **22**, 113-124.

Torkildsen, G. (1992). Leisure and recreation management. (3rd ed.). London: E & FN Spon. pp. 65-69.

Turner, A. K., and Miles, R. D. (1971). The GCARS system: computer assisted method of regional route location. Highway Research Record 348. Washinton. pp. 1-15.

Turner, M. G. (1989). Landscape ecology: the effect of pattern on process. Annual Review of Ecology and systematics, **20**, 171-197.

Turner, R. K., Pearce, D. W., and Bateman, I. (1994). Environmental Economics: an elementary introduction. Harvester Wheatsheaf. pp. 1-328.

US Bureau of Outdoor Recreation. (1977). Guidelines for understanding and determing optimum recreation carrying capacity. Washington, DC. US Bureau of Outdoor Recreation.

Vink, A. P. A. (1982). Landscape ecological mapping. ITC Journal, **3**, 338-343.

Vodak, M. C., Roberts, P. L., Wellman, J. D., and Buhyoff, G. J. (1985). Scenic impacts of eastern hardwood management. Forest Science, **31**, 289-301.

Walker, P., and Faith, D. P. (1993). Diversity: a software package for sampling phylogenetic and environmental diversity. Division of wildlife and ecology, CSIRO, PO Box 84, Lyneham, ACT 2602, Australia.

Wall, G., and Wright, C. (1977). The environmental impact of outdoor recreation. Department of Geography, University of Waterloo. pp. 1-68.

Wegge, T., Hanemann, W. M., Loomis, J., and Hall, D. C. (1996). Comparing benefits and costs of water resource allocation policies for California's Mono basin. Advances in the economics of environmental resources. Advances in the economics of environmental resources. Volume 1: Marginal cost rate design and wholesale water markets. JAI Press Ltd, Middlex, UK. pp. 11-30.

Whitehead, J. C., Blomquist, G. C., Hoban, T. J., and Clifford, W. B. (1995). Assessing the validity and reliability of contingent values: a comparison of on-site users, off-users, and non-users. Journal of Environmental Economics and Management, **29**(2), 238-251.

Wiberg-Carlson, D., and Schroeder, H. Modelling and mapping urban bicyclists' preferences for trail environments. (1992). North Central Forest Experiment Station: Forest service- U.S. Department of Agriculture. NC-303, pp. 1-11.

Willis, K. G., and Garrod, G. D. (1991). Landscape values: a contingent valuation approach and case study of the Yorkshire Dales National Park, Countryside Change Working Paper 21, Countryside Change Unit, University of Newcastle upon Tyne.

Willis, K. G., and Garrod, G. D. (1992). Assessing the value of future landscapes. Landscape and Urban Planning, **23**, 17-32.

Wolhwill, J. (1973). The environment is not in the head. In W. Preiser (Ed.), Environmental design research. Stroudsburg, Penn: Dowden, Hutchinson, and Ross.

Wood, T. F. (1987). The analysis of environmental impacts resulting from summer recreation in the Cairngorm Ski Area, Scotland. Journal of Environmental Management, **25**, 271-284.

Wossink, G. A. A., Buys, J. C., Jurgens, C. R., Snoo, G. R. D., and Renkema, J. A. (1996). What, how and where: nature conservation and restoration in sustainable agriculture. In VII-th European Congress of Agricultural Economists: Edinburgh. 3, September, 1996.

Wossink, G. A. A., Jurgens, C. R., and Wenum, J. H. V. (1996). Optimal allocation of nature conservation areas within agricultural land. In Concerted Action AIR 3: Policy Measures to Control Environmental Impacts from Agriculture, Workshop landscape and nature conservation: Hohenheim: Workshop landscape and nature conservation. 26, September, 1996. pp. 1-15.

Yang, P. S., and Liu, J. Y. (1988). Insect study of Chitou. Quarterly Journal of Experimental Forest, NTU, **2**(4), 132-128.

Yao, Y. N., Liu, J. Y., Hung, I. K., and Chi, M. Y. (1995) Ecotourism in Chitou-retrospection and prospection. The Experimental Forest, N.T.U. pp. 1-12.

Yiannakis, A., Leivadi, S., and Apostolopoulos, Y. (1991). Some cross-cultural patterns in tourist role preference: a study of Greek and American tourist behaviors. Some Cross-Cultural Patterns, pp. 33-37.

Young, T. N., Eby, J. R., Allen, H. L., Hewitt III, M. J., and Dixon, K. R. (1987). Wildlife habitat analysis using landsat and radiotelemetry in a GIS with application to spotted owl preference for old growth. In GIS '87-San Francisco. Second annual international conference, exhibitions & workshops on G.I.S. San Francisco. 26, October, 1987. pp. 595-600.

Zee, D. v. (1986). Analysis and evaluation of recreational resources with the aid of remote sensing. In Remote sensing for resources development and environmental management. Proceedings of the 7th International Symposium of the ISPRS, Enschede, 25-29 August 1986. Commission VII: Interpretation of photogrammetry and remote sensing, **26**: 7/2. pp. 887-892.

Zee, D. v. (1987). The recreational resources of the Mae Sa Valley viewed in some theoretical context. (A challenge for further research and reflection). In proceedings of the seminar on "The role of geography in the tourism development', Geographical Association of Thailand, Kanchanaburi. 26, October, 1987. pp. 66-68.

Zee, D. v. (1988). Down by the waterfall. The waterfall sites of the Mae Sa Valley area analysed and evaluated as recreational resources. ITC, Enschede.

Zee, D. v. (1988). The importance of the spatial aspect in the evaluation of recreational resources in the landscape. In Proceedings of the VIIIth International Symposium on Problems of landscape Ecological research, Theme 1: Spatial Relations in Landscape Ecology, Zemplinska Sirava, Czechoslovakia, 3-7, October, 1988, **1**: 85-91.

Zee, D. v. (1990). The complex relationship between landscape and recreation. Landscape Ecology, **4**(4), 225-236.

Zhou, G., and Liebhold, A. M. (1995). Forecasting gypsy moth defoliation with a geographical information system. Entomologai Sinica, **2**(1), 83-94.

Zonneveld, I. S. (1979). Chapter VII. Second, amended and corrected edition, ITC, Enschede. In Land evaluation and landscape science. ITC textbook of photo-interpretation, Vol.VIII.

Appendix A. Questionnaire to assess visitor satisfaction with recreational facilities of Chitou

Questionnaire To Assess Visitor Satisfaction With Recreational Facilities Of Chitou

PART I

Date__________, 1995

VARIABLES	Question	Alternatives	Answer
REASON FOR VISIT	**1.** What's the reason attracting you to Chitou? (multiple choice; write the answers in order)	1). landscape /viewpoints watching 2). wildlife interest /bird seeing/conservation 3). nature forest/man-made forest 4). fame/ a resort 5). research purpose 6). group/school tour activities 7). avoid from hot weather 8). recreation facility using 9). near/convenient transportation 10). cheap entrance fee 11). no special reason 12). the others ________________	(Please write down the No. of answer) **1.**
PARK IMPRESSIONS	**2.** Which characters of Chito do you like most after traveling? (multiple choice; write the answers in order)	1). landscape /viewpoints 2). path design/the landscape along paths 3). wildlife /bird seeing 4). conservation /natural landscape 5). cool temperature and quiet environment 6). research characters 7). recreation facilities 8). the others________________	**2.**

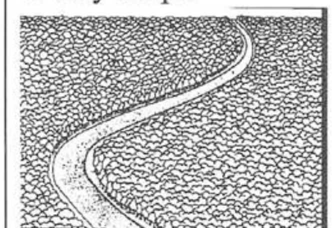
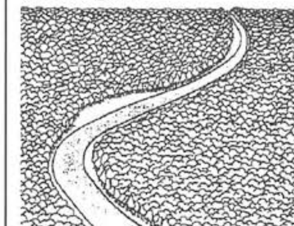
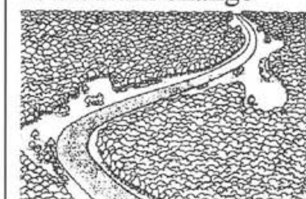
VARIABLES	Question	Alternatives	Answer
FAVOURITE VIEWPOINT ***LEAST FAVOURITE VIEWPOINT***	**3a.** What were your favourite viewpoints? (Please write the No.s in order) **3b.** What were your least favourite viewpoints? (Please write the No.s in order)	1. Red mansion 2. Campsites 3. Picnic Area 4. Bamboo living collection garden 5. Nursery 6.Deer garden 7.Ginkgo forest 8.Man-made forest 9.Natural forest 10.The great Chamaecyparis formosensis spiritual tree 11.The Mount Fonghuang observation tower 12.Moso Bamboo & Bamboo house 13.University Pond 16.the others ____________	Ans: **3a.** **3b.**

VARIABLES	Question	Alternatives	Preference	Answer
FOREST1- conifers ***FOREST2***- broad-leaved ***FOREST3***- mixed ***FOREST4***- bamboo ***FOREST5***- natural ***FOREST6***- lawn	**4.** What kind of plantation do you like to see more?	1. man-made conifers 2. man-made broad-leaved trees 3. man-made mixed forest 4. bamboo forest 5. nature forest 6. forest rest lawn 7. the others____________	1:2:3:4:5 1:2:3:4:5 1:2:3:4:5 1:2:3:4:5 1:2:3:4:5	Ans: 1. 2. 3. 4. 5.

VARIABLES	Question	Alternatives		Answer
SEASON COLOUR PREFERENCE	**5a.** Do you like the color of scenery of Chito changing seasonally?	1. Yes 2. No		Ans: **5a.**
			Dislike **Like**	**5b.**
RED	**5b.** What percent of each color in a landscape do you prefer?	1. red	(0------------------------100%)	1.
DARK GREEN		2. dark green	(0------------------------100%)	2.
LIGHT GREEN		3. light green	(0------------------------100%)	3.
YELLOW		4. yellow	(0------------------------100%)	4.
ORANGE		5. orange	(0------------------------100%)	5.
BROWN		6. brown	(0------------------------100%)	6.
BRIGHTNESS		7. bright	(0------------------------100%)	7.

VARIABLES	Question	Alternatives		Answer
			Dislike Like	Ans:
LANDSCAPE1- simple	6a. What kind of landscape do you prefer?	1. Simple 	(-5----------0---------+5)	1.
LANDSCAPE2- less simple		2. Medium 	(-5----------0---------+5)	2.
LANDSCAPE3- less complex		3. Complicated 	(-5----------0---------+5)	3.
LANDSCAPE4- complex		4. Very Complicated 	(-5----------0---------+5)	4.

VARIABLES	Question	Alternatives		Answer
			Dislike Like	Ans:
PURE FOREST	6b. What kind of forest do you prefer?	1. pure forest 	(-5----------0---------+5)	1.
MIXED FOREST		2. mix forest 	(-5----------0---------+5)	2.

VARIABLES	Question	Alternatives		Answer
PLANTATION ARRANGEMENT PREFERENCE	6c. Please choose your <u>most</u> and <u>least</u> favourite landscape arrangement along footpaths from the choices on your right.	1. very simple  3. little change  5. big change 	2. simple  4. medium change  6. change dramatically 	6c. 1.(most)___ 2.(least)___

VARIABLES	Question	Alternatives	Answer
SOCIAL FACILITY ATISFACTIONSATISFY	**7a.** Are you satisfied with the facilities (ex. **toilet, hotels, bins, signposts, shops, etc.**) in Chito?	1. Yes(go to **8.)** 2. No (go to **7b.7c**)	Ans: **7a.**
DISSATISFACTION REASON	**7b.** Which facilities you don't like? **7c.** Why?	1. not enough facilities 2. poor maintenance 3. unsuitable location 4. the others________	**7b.**__________ **7c.**__________

VARIABLES	Question	Alternatives	Answer
FACILITY AMOUNT	**8a.** Do you think there are enough facilities in Chitou?	1. Yes 2. No	**8a.**
FACILITY REQUIRED	**8b.** If the manager of Chito is going to improve facilities, what kind of facilities do you prefer to be built?	1. viewpoints 6. chairs 2. footpaths/paths 7. route maps 3. sheds 8. signposts 4. play yards & facilities 9. tour guide 5. campsites facilities 10.the others________	**8b.**

VARIABLES	Question	Alternatives	Answer
ENOUGH VIEWPOINT	**9.** Do you think there are enough viewpoints in Chito?	1. Yes 2. No	Ans: **9.**
VISIT FREQUENCY	**10.** Would you visit more frequently if more viewpoints were created?	1. Yes 2. No	**10.**
INFORMATION LEVELS	**11.** Do you think the information about this site and viewpoints enough?	1. Yes 2. No	**11.**
(OMIT)	**12.** What kind of information do you hope to get?		**12.**__________
WHEN NEXT VISIT	**13.** When would you visit Chito again?	1.this year 2.next year 3.sometimes 4.never	**13.**

(NT$: New Taiwanese Dollars)

VARIABLES	Question	Alternatives	Answer
TICKET	**14.** What the Entrance Fee did you pay for this visiting to Chito?	1.NT$30 2.NT$60 3.NT$80 4.NT$100	**14.**
PRICE	**15.** Do you think that the current Entrance Fee is :	1. cheap 2. reasonable 3. expensive	**15.**
WTPVIEWYES	**16.** Imagine there were more/better **viewpoints** (ie. there were higher <u>aesthetic quality</u>), would you be willing to pay more as an entrance fee?	1.Yes(go to **16a.**) 2. No	**16.**
WTP VIEW	**16a.** if <u>Yes</u>,--- how much more would you pay?	1. NT$1-5 2. NT$6-10 3. NT$11-15 4. NT$16-20 5.>NT$20_______ (specify please)	**16a.**

VARIABLES	Question	Alternatives	Answer
WTP CONSERVATION-	**17.** Imagine Chito were going to close because insufficient funds from felling were available to run the park considering ecology conservation. If a charity fund was to be set up which would be used only to run the park, would you be willing to contribute to the fund. If yes---- how much would you pay?	1. NT$1-5 2. NT$6-10 3. NT$11-15 4. NT$16-20 5. >NT$20_______ (specify please)	Ans: **17.**
MAXIMUM TRANSPORTATION HOUR	**18.** Will you give up travelling to Chitou when it takes such a long time for transportation as below?	1. more than 3 hrs 2. more than 4 hrs 3. more than 5 hrs 4. more than 6 hrs 5. the others(more than____hrs)	**18.**

VARIABLES	Question	Alternatives	Answer
PARK PREFERENCE ORDER *(OMIT)*	**19.** If those recreation sites or parks as below have the same distance from your house and have the same Entrance Fee, what's the order that you would like to visit? *Why?	1. Chito recreation area 2. Yangming Mountain National park 3. Wu-Lie recreation area 4. Shan-Lin- Si recreation area 5. Kending national park	Ans: **19.** *__________
VISITOR CHOICE	**20.** What are the most important factors affecting your decision on which park to visit?	1.amenity of landscape 2.crowded degree 3.entrance fee 4.transportation 5.natural/man-made environment 6.the situation of paths in the parks. 7.the others__________	**20.**

PART II # BACKGROUND OF VISITORS

VARIABLES	Question	Alternatives	Answer
SEX	1. Sex	1.Female 2.Male	Ans: 1.
ADDRESS	2. Where are you from?(city)		2.__________
TRANSPORTATION TIME	3. How long did you spend for travelling to here?		3.__________
TRANSPORTATION FEE	4. What's your travel fee for arriving Chito?		4.
EDUCATION	5. Please could you indicate your level of education?	1. Elementary school 2. Junior high school 3. High school 4. University/Polytech 5. The others	5.
AGE	6. When were you born?		6.________
INCOME	7. What's your monthly salary?		7.________

VISIT TIMES	8. How many times including this time have you visited Chito?	Ans: 8.______time(s)
DURATION	9. If your vacation is long enough, how many days will you like to stay in Chito?	9.______day(s)
TOTAL VISITORS	10. How many persons in your group?(concluding yourself) 10a.Adult-______ persons (more than 18 years old)	10.____person(s) 10a.____person(s)
CHILDREN	10b.Children-_______ persons	10b.____person(s)

Thank you very much for your help!!

Appendix B. Questionnaire to assess visitor reaction to crowd experience of Chitou

Questionnaire to assess visitor reaction to crowd experience of Chitou

PART I

Viewpoint Location:........................Date............,1995 ***(INTERVIEW SITE)***
Visitors around________ ***(VISITOR DENSITY)***

VARIABLES	Question	Alternatives	Answer
			Ans:
CROWDEDEXPERIENCE	**1.** Do you feel crowded in Chito?	1. Yes 2. No	**1.**
CROWD VIEW 1 ***CROWD VIEW 2*** ***CROWD VIEW 3*** ***CROWD VIEW 4*** ***CROWD VIEW 5*** ***CROWD VIEW 6***	**2.** Which viewpoints did you feel crowded?	1. Red Mansion 2. Campsites 3. Gingo Plantation 4. The great spiritural tree 5. University Pond 6. the others ________________	**2.**
MAXIMUM NUMBER PEOPLE	**3.** How many persons around you in the footpath you will feel crowded?		**3.**____persons
IMPROVEMENT.1 ***IMPROVEMENT.2*** ***IMPROVEMENT.3*** ***IMPROVEMENT.4*** ***IMPROVEMENT.5***	**4.** What kind of improvement at Chitou do you think that you would feel less crowded?	1. build more footpahts 2. widen the paths 3. limit the access of visitors 4. no methods 5. the other opinions________	**4.**
BLOCK IDENTIFICATION 1 ***BLOCK IDENTIFICATION 2*** ***BLOCK IDENTIFICATION 3***	**5.** Where do you think the footpaths should be created? **(see Footpath Map)**	*Please point it out from **Division 1-11** based on the priority.	**5.___Division**

VARIABLES	Question	Alternatives		Answer
PATH LIKES ***PATH DISLIKES***	5b. Would you prefer the footpaths being built as---	1. Staircase  2. Tarmacadam road (Tar)  3. Slate surface road 	4. Pebble road  5. Earth surface road 	5b.

VARIABLES	Question	Alternatives	Answer
PRESENT FOOTPATH SATISFACTION	**6a.** Generally speaking, how were you satisfied with the footpaths in Chito? *If the answer is negative, why?	not satisfied very satisfied -5 -4 -3 -2 -1 0 1 2 3 4 5	Ans: **6a.** * ________
ROUTES VISITED (23 variables)	**7a.** Which routes did you choose? Please write the **No.s** down in order based on the **Footpath Map** attched?	(**ex.**1-2-6-5-3-4-1)	**7a.**
REASEONs FOR ROUTE SELECTION	**7b.** Why did you choose these routes? Because you considered	1. the viewpoints which you were interested in visiting. 2. the limited time. 3. the distance of routes/physical limitation 4. the landscape along footpaths 5. chose them by chance 6. follow a crowd 7. the other reasons____________	**7b.**
PREFERRED PATHS (23 variables)	**7c.** Please recall which sections you liked? (multiple choice; Please put them in order if you can.) **(see Footpath Map)**	For example, 1,5 9-13	**7c.**
FEATURES LIKED	**7d1.** What aspects of the walks did you like to meet? (multiple choice)	1.nature forest 2.man-made forest 3.water/ponds/bridges 4. lawn/space in forest 5. ornament plants/ cultural flowers 6. recreation facilities 7. buildings 8. wildlife_______________ 9. visitors 10. art works, e.q. sculpture 11. the others__________________	**7d1.**

VARIABLES	Question	Alternatives	Answer
FEATURES NOT LIKED (8 variables)	**7d2.** What didn't you like to see along the footpath? (multiple choice)	1. man-made forest 2. buildings 3. noisy people 4. car driving 5. snakes 6. rubbish 7. barren 8. the others________________	Ans: **7d2.**
FACILITY LOCATION	**7e.** Where do you expect the public facilities like toilet and bins, etc. built?	1. far away from footpaths 2. by the footpaths 3. the others____________	**7e.**
ACTIVITY PREFERRED 1 ***ACTIVITY PREFERRED 2*** ***ACTIVITY PREFERRED 3*** ***ACTIVITY PREFERRED 4*** ***ACTIVITY PREFERRED 5*** ***ACTIVITY PREFERRED 6***	**8.** What did you usually do while you were walking on footpaths in Chitou? (multiple choice, please specify the order if you can.)	1.walking only 2. landscape watching 3. chatting 4. eating 5. photographing 6. wildlife and plants watching 7. the others___________	**8.**
FOOTPATH DESIGN	**9.** What kind of footpaths do you prefer?	1.wide (>1M) & strait 2. wide (>1M) & circle 3. narrow & strait 4. narrow & circle	**9.**
SIGNPOSTS	**10.** Do you think the signposts in Chitou--	1. enough and clear 2. enough but not clear 3. not enough but clear 4. not enough and not clear	**10.**

VARIABLES	Question	Alternatives	Answer
DECREASE CROWD DENSITY	**11.** If the crowdedness of the park were to decrease (ie.let fewer people in at any one time), would you be willing to pay more as an entrance fee?	1.yes(go to **11a & 11b**) 2.no(go to **11c**)	**11.**
	*IF **Yes**,---how much more would you pay if the people decreased by	1. NT$1-5 2. NT$6-10 3. NT$11-15 4. NT$16-20 5. >NT$20	**11a**
DECREASE 50%	**11a.**1/2?		**11b.**
DECREASE 25%	**11b.**1/4?		
LOSS OF VISITORS	**11c.**For the same entrance fee, when will you give up travelling to Chitou, in the case of the crowdiness of Chitou increased to the extent below?	1. 1/6 2. 1/4 3. 1/2 4. 2 times 5. no effect	**11c.**

PART II

THE BACKGROUND OF VISITORS

VARIABLES	**Question**	**Alternatives**	**Answer**
SEX	1. Sex	1.Female 2.Male	Ans: 1.
ADDRESS	2. Where are you from?(city)		2.__________
TRANSPORTATION TIME	3. How long did you spend for travelling to here?		3.__________
TRANSPORTATION FEE	4. What's your travel fee for arriving Chito?		4.
EDUCATION	5. Please could you indicate your level of education?	1. Elementary school 2. Junior high school 3. High school 4. University/Polytech 5. the others	5.
AGE	6. When were you born?		6.________
INCOME	7. What's your monthly salary?		7._________

VISIT TIMES	8. How many times including this time have you visited Chito?	Ans: 8.______time(s)
DURATION	9. If your vacation is long enough, how many days will you like to stay in Chito?	9.______day(s)
TOTAL VISITORS	10. How many persons in your group?(concluding yourself) 10a.Adult-______ persons (more than 18 years old)	10.____person(s) 10a.____person(s)
CHILDREN	10b.Children-_______ persons	10b.____person(s)

Thank you very much for your help!!

Appendix C. Questionnaire to assess visitor reaction to landscape components in Chitou

PHOTOGRAPH QUESTIONNAIRE

1. CONTINGENT VALUATION OF PHOTOGRAPHS UNITS Date__________, 1995

VARIABLES	Question	Attributes	Answer
	1. Please write down the three priority features of the prefer photograph of each photo. unit.		**1.**
FOOTPATH LIKE	1.Photograph unit 1 (A,B,C,D)	1. four kinds of footpaths A. tarmacadam road B. slab road C. pebble road D. earth road	1.________ ________ ________ 2.________ ________ ________
FOREST COMPOSITION LIKE	2.Photograph unit 2 (A,B,C,D)	2. forest types A. conifer B. broad-leaved trees C. mix forest D. bamboo forest	3.________ ________ ________
CROWD LIKE	3.Photograph unit 3 (A,B,C)	3. crowdedness A. many people B. less people C. no people	4.________ ________ ________
COLOUR COMPOSITION LIKE	4.Photograph unit 4 (A,B)	4. color preferences A. green B. colorful	5.________ ________ ________
BRIDGE LIKE	5.Photograph unit 5 (A,B)	5. specific landscape features A. water bodies;bridges B. no water bodies; bridges	6.________ ________ ________
STAND STRUCTURE LIKE	6.Photograph unit 6 (A,B)	6. stand structure A. multiple-storied forest B. single-storied forest	

VARIABLES	Questions	Answers
	2. Continue the **<u>Q1</u>,** please circle the preference of each photograph .	**Dislike** **Like**
FOOTPATH LIKE EXTENT ***(4 variables)***	1.Photograph pair 1 (A,B,C,D)	**1A** -5:-4:-3:-2:-1: 0 :1:2:3:4:5 **B** -5:-4:-3:-2:-1: 0 :1:2:3:4:5 **C** -5:-4:-3:-2:-1: 0 :1:2:3:4:5 **D** -5:-4:-3:-2:-1: 0 :1:2:3:4:5
FOREST COMPOSITION LIKE EXTENT ***(4 variables)***	2.Photograph pair 2 (A,B,C,D)	**2A** -5:-4:-3:-2:-1: 0 :1:2:3:4:5 **B** -5:-4:-3:-2:-1: 0 :1:2:3:4:5 **C** -5:-4:-3:-2:-1: 0 :1:2:3:4:5 **D** -5:-4:-3:-2:-1 :0 :1:2:3:4:5
CROWD LIKE EXTENT ***(3 variables)***	3.Photograph pair 3 (A,B,C)	**3A** -5:-4:-3:-2:-1: 0 :1:2:3:4:5 **B** -5:-4:-3:-2:-1: 0 :1:2:3:4:5 **C** -5:-4:-3:-2:-1: 0 :1:2:3:4:5
COLOUR COMPOSITION LIKE EXTENT (2 variables)	4.Photograph pair 4 (A,B)	**4A** -5:-4:-3:-2:-1: 0 :1:2:3:4:5 **B** -5:-4:-3:-2:-1: 0 :1:2:3:4:5
BRIDGE LIKE EXTENT ***(2 variables)***	5.Photograph pair 5 (A,B)	**5A** -5:-4:-3:-2:-1: 0 :1:2:3:4:5 **B** -5:-4:-3:-2:-1: 0 :1:2:3:4:5
STAND STRUCTURE LIKE EXTENT (2 variables)	6.Photograph pair 6 (A,B)	**6A** -5:-4:-3:-2:-1: 0 :1:2:3:4:5 **B** -5:-4:-3:-2:-1: 0 :1:2:3:4:5

2. PHOTOGRAPH CARDS OF TYPICAL LANDSCAPE TYPES OF CHITO

LARGE SCALE'S VIEW (The same design applied to the Small Scales (The variable names are shown in parentheses)

VARIABLES	Question	Attributes A	Attributes B	Answer
	A. Please point out what you think are the most favourite and least favourite photographs.	A	B	Ans:
		1. water body	no water body	**1. No. of photo**____
		2. bridge	no bridge	feature 1________
		3. good rrangement of scenery	bad arrangement of scenery	
Most favoured photograph in Large Scale (Most favoured photograph in Small Scale)	1. For the most favourite photograph, which features do you prefer ? (multiple choice, please choose from attributes based on the priority)	4. good design of footpaths	bad design of footpaths	feature 2________
		5. material of footpaths-- like	material of footpaths--	
		6. the diversity of landscape	dislike	feature 3________
Preferred Large Scale Features 1		7. colorful	boring	
(Preferred Small Scale Features 1)		8. conifers	plain	
Preferred Large Scale Features 2		9. natural feaures	broad-leaved trees	
(Preferred Small Scale Features 2)		10. mountains	unnatural features	
Preferred Large Scale Features 3		11. sky	plain	**2. No. of photo**____
(Preferred Small Scale Features 3)		12. eyesore	no sky	feature 1________
		13. brightness	no eyesore	
		14. large scale	darkness	feature 2________
		15. the	small scale	
Least favoured photograph in Large Scale (Least favoured photograph in Small Scale)	2. For the least favourite photograph, which features do you dislike? (multiple choice, please choose from attributes based on the priority)	others________		feature 3________
Least Preferred Large Scale Features 1				
(Least Preferred Small Scale Features 1)				
Least Preferred Large Scale Features 2				
(Least Preferred Small Scale Features 2)				
Least Preferred Large Scale Features 3				
(Least Preferred Small Scale Features 3)				

VARIABLES	Questions
	B. (continue A) For the both <u>most & least favourite</u> Large Scale photographs, please circle one scale from below:
	3a. For the <u>most favourite</u> photo---
1. SCALE in Large (Small) Photograph	1. Large scale 5 4 3 2 1 2 3 4 5 Small scale
2. COMMONNESS in Large (Small) Photograph	2. Common 5 4 3 2 1 2 3 4 5 Unusual
3 ANGULARNESS in Large (Small) Photograph	3. Angular 5 4 3 2 1 2 3 4 5 Rounded
4. BRIGHTNESS in Large (Small) Photograph	4. Bright 5 4 3 2 1 2 3 4 5 Dull
5. HARDNESS in Large (Small) Photograph	5. Hard 5 4 3 2 1 2 3 4 5 Soft
6. OPENNESS in Large (Small) Photograph	6. Open 5 4 3 2 1 2 3 4 5 Close
7. VARIEDNESS in Large (Small) Photograph	7. Varied 5 4 3 2 1 2 3 4 5 Monotonous
8. NATURALNESS in Large (Small) Photograph	8. Natural 5 4 3 2 1 2 3 4 5 Man-made
9. COLORFULNESS in Large (Small) Photograph	9. Colorful 5 4 3 2 1 2 3 4 5 Colourless
10. SCENICNESS in Large (Small) Photograph	10. High scenic 5 4 3 2 1 2 3 4 5 Low scenic value
11. INTERESTING in Large (Small) Photograph	11. Interesting 5 4 3 2 1 2 3 4 5 Boring
12. OBVIOUSNESS in Large (Small) Photograph	12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious
13. BEAUTIFULNESS in Large (Small) Photograph	13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly
14. PEACEFULNESS in Large (Small) Photograph	14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded
15. PLEASANTNESS in Large (Small) Photograph	15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant
	3b. For the <u>least favourite</u> photo---
1. SCALE in Large (Small) Photograph	1. Large scale 5 4 3 2 1 2 3 4 5 Small scale
2. COMMONNESS in Large (Small) Photograph	2. Common 5 4 3 2 1 2 3 4 5 Unusual
3 ANGULARNESS in Large (Small) Photograph	3. Angular 5 4 3 2 1 2 3 4 5 Rounded
4. BRIGHTNESS in Large (Small) Photograph	4. Bright 5 4 3 2 1 2 3 4 5 Dull
5. HARDNESS in Large (Small) Photograph	5. Hard 5 4 3 2 1 2 3 4 5 Soft
6. OPENNESS in Large (Small) Photograph	6. Open 5 4 3 2 1 2 3 4 5 Close
7. VARIEDNESS in Large (Small) Photograph	7. Varied 5 4 3 2 1 2 3 4 5 Monotonous
8. NATURALNESS in Large (Small) Photograph	8. Natural 5 4 3 2 1 2 3 4 5 Man-made
9. COLORFULNESS in Large (Small) Photograph	9. Colorful 5 4 3 2 1 2 3 4 5 Colourless
10. SCENICNESS in Large (Small) Photograph	10. High scenic 5 4 3 2 1 2 3 4 5 Low scenic value
11. INTERESTING in Large (Small) Photograph	11. Interesting 5 4 3 2 1 2 3 4 5 Boring
12. OBVIOUSNESS in Large (Small) Photograph	12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious
13. BEAUTIFULNESS in Large (Small) Photograph	13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly
14. PEACEFULNESS in Large (Small) Photograph	14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded
15. PLEASANTNESS in Large (Small) Photograph	15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant

3. THE BACKGROUND OF VISITORS

VARIABLES	Question	Alternatives	Answer
SEX	1. Sex	1.Female 2.Male	Ans: 1.
ADDRESS	2. Where are you from?(city)		2.__________
TRANSPORTATION TIME	3. How long did you spend for travelling to here?		3.__________
TRANSPORTATION FEE	4. What's your travel fee for arriving Chito?		4.
EDUCATION	5. Please could you indicate your level of education?	1. Elementary school 2. Junior high school 3. High school 4. University/Polytech 5. the others	5.
AGE	6. When were you born?		6.________
INCOME	7. What's your monthly salary?		7._________

VISIT TIMES	8. How many times including this time have you visited Chito?	Ans: 8.______time(s)
DURATION	9. If your vacation is long enough, how many days will you like to stay in Chito?	9.______day(s)
TOTAL VISITORS	10. How many persons in your group?(concluding yourself) 10a.Adult-______ persons (more than 18 years old)	10.____person(s) 10a.____person(s)
CHILDREN	10b.Children-_______ persons	10b.____person(s)

Thank you very much for your help!!

Appendix D. The Visitor Background of Questionnaire Survey in Chitou in Summer, 1995

Questionnaire		**Satisfaction**		**Crowding**		**Landscape Preference**	
	Items	%		%		%	
Sex	Male	50.7	X^2=.0407 DF=1	58.9	X^2=7.5472 DF=1	52.3	X^2=.4630 DF=1
	Female	49.3	P=.8401	40.6	P=.0060	47.7	P=.4962
Age	< 12	**	X^2=101.9955	**	X^2=118.8182	**	X^2=168.6111
	13-18	26.9	DF=5	14.4	DF=5	20.3	DF=6
	19-24	23.3	P=.0000	31.1	P=.0000	27.8	P=.0000
	25-34	29.6		33.5		34.7	
	35-44	16.6		17.7		13.4	
	45-55	3.1		1.4		2.3	
	> 55	0.4		1.9		1.4	
Education	Elementary S.	1.3	X^2=223.3004	2.4	X^2=213.6190	0.9	X^2=203.9537
	Junior High S.	7.2	DF=4	7.1	DF=4	9.3	DF=4
	High School	35.0	P=.0000	35.7	P=.0000	35.2	P=.0000
	Univ./polytech	52.0		51.9		50.5	
	the others	4.5		2.9		4.2	
Income	NT$0	42.6	X^2=302.1569	41.6	X^2=316.5742	29.6	X^2=169.1852
	NT$1-10000	7.2	DF=9	5.7	DF=8	7.4	DF=9
	NT$10001-20000	8.1	P=.0000	7.7	P=.0000	11.1	P=.0000
	NT$20001-30000	16.1		17.7		19.9	
	NT$30001-40000	9.4		9.1		14.8	
	NT$40001-50000	7.2		7.2		9.7	
	NT$50001-60000	1.8		2.9		2.8	
	NT$60001-70000	2.2		1.4		2.3	
	NT$70001-80000	2.7		1.0		0.5	
	NT$80001-200000	2.7		5.7		1.9	
Visit time	first time	12.2	X^2=80.4118	12.3	X^2=167.1043	13.1	X^2=159.9014
	2-5 times	50.7	DF=3	63.5	DF=3	62.4	DF=3
	6-10 times	17.2	P=.0000	13.3	P=.0000	14.1	P=.0000
	> 11 times	19.9		10.9		10.3	

(**: Respondents of visitors under the age of 12)

(Continued). The Distribution of Population in Taiwan in 1992

Background	**Category**	**No. of People**	**Percent of People**
Sex	Male	10,708,281	51.60
	Female	10,044,213	48.40
Age	< 12	4,535,257	21.86
	13-18	2,316,672	11.16
	19-24	2,209,712	10.65
	25-34	3,852,377	18.56
	35-44	3,158,997	15.22
	45-55	1,765,125	8.51
	> 55	2,914,354	14.04
Accommodation	North Area	8,351,822	40.24
	Middle Area	4,473,373	21.56
	South Area	6,859,471	33.05
	East Area	1,067,828	5.15
	Total	20,752,494	

(Statistical data of Taiwn population published by the Ministry of the Interior, Republic Of China, 1993)

Appendix E. The summary of IDRISI software's modules used in this study (IDRISI Technical Reference manual, 1992)

BUFFER: A buffer zone can be defined to a point, a line or an area.

COST: Generates a distance/proximity surface (also referred to as a cost surface) where distance is measured as the least effort in moving over a friction surface.

DATA IMPORT: This option allows the movement of data from the other IDRISI for Windows values file formats (VAL and FXL files) using a full relational join (i.e., imported values are associated with the correct record based upon their identifier).

DISTANCE: Calculate the distance between each cell and the nearest of a set of target features.

MCE: MCE is a decision support tool for Multi-Criteria Evaluation. The basis for a decision is known as a criterion. In a Multi-Criteria Evaluation, an attempt is made to combine a set of criteria to achieve a single composite basis for a decision according to a specific objective.

OVERLAY: Produces a new image from the data of two input images. New values result from applying one of the nine possible operations to the two input images, referred to as the first and second images during program operation.

PATHWAY: Determines the least cost route between one or more target cells and one or more lower terminal cells on an accumulated cost surface.

SCALAR: does scalar arithmetic on images by adding, subtracting, multiplying, dividing or exponentiating the pixels in the input image by a constant value.

TRANSFOR: undertakes attribute transformations on images (such as converting the data values in an image to the natural logarithms of those values).

VIEWSHED: Determines all cells visible from one or more viewpoint cells situated on a surface. Output is a new image in which cells in view are assigned a value 1, viewpoint cells are assigned a value 2, and cells not in view are coded as zeros.

WEIGHT: WEIGHT is used to develop a set of relative weights for a group of factors in a multi-criteria evaluation (MCE).

SURFACE: calculates slope, aspect and shaded relief images from a digital elevation model, and can create shaded relief images from slope and aspect images.

Appendix F. Chitou Planting Database

Compartment	Stand_No	Average Height	Planting Year	1992age	Stand Code*	Tree Label*	Total Area	Volume_82	Volume_Class	Density_76	Elevation	Slope
2001	53		1923	70	400	101	0.260	184	5	1000	0	0
2002	61		1925	68	400	103	5.000	1228	4	0	0	32
2003	89		1929	64	400	101	0.270	0	1	0	0	10
2004	115		1933	60	400	103	1.540	5	1	233	0	25
2005	125		1935	58	450	601	6.100	0	1	0	0	40
2006	132		1937	56	400	101	8.500	2279	4	550	0	30
2007	140		1939	54	400	101	0.200	30	3	0	0	38
2008	159		1943	50	400	101	4.600	0	1	0	0	25
2009	2-33		1944	49	400	101	0.570	56	2	0	0	0
2010	161		1945	48	400	101	4.460	1878	5	790	0	20
2011	168-1		1947	46	400	101	1.050	523	5	0	0	40
2012	168-2	17.54	1947	46	400	101	8.340	3330	5	1040	0	36
2013	168-3		1947	46	400	101	1.100	424	4	0	0	30
2014	175		1951	42	400	101	0.760	514	5	1460	0	0
2015	177		1952	41	400	101	4.400	1699	4	0	0	35
2016	178		1952	41	400	101	5.540	2225	5	0	0	0
2017	197	17.18	1956	37	400	101	14.860	4841	4	2020	0	0
2018	200	18.3	1956	37	400	102	1.650	770	5	0	0	0
2019	46-3		1957	36	400	101	3.920	1200	4	1320	0	0
2020	46-4	16.28	1957	36	400	101	6.020	1588	4	0	0	0
2021	49-1	16.54	1960	33	400	101	10.180	3363	4	1240	0	0
2022	49-3		1960	33	450	601	3.600	870	4	1280	0	0
2023	49-6		1960	33	400	101	0.580	202	4	0	0	0
2024	50-1	15.75	1961	32	600	701	48.270	7158	3	1060	0	0
2025	51-2		1962	31	600	701	2.160	704	4	1060	0	0
2026	52-2	14.49	1963	30	400	101	2.320	383	3	1100	0	0
2027	52-3	15.57	1963	30	400	101	2.740	425	3	1100	0	0
2028	52-4	16.04	1963	30	450	601	33.050	188	1	0	0	0
2029	54-2		1965	28	400	101	3.490	806	4	1220	0	0
2030	55-1	15.51	1966	27	400	104	16.400	5865	4	1280	0	0
2031	56-1	14.54	1967	26	450	601	13.060	4804	4	1410	0	0

2032	2-57		1968	25	400	101	0.450	0	1	0	0	0
2033	58-1		1969	24	600	601	12.960	2875	4	2250	0	0
2034	58-2		1969	24	400	105	0.220	45	4	0	0	0
2035	60-1		1971	22	450	104	3.870	1393	4	1340	0	0
2036	60-2		1971	22	450	104	6.560	1263	3	1380	0	0
2037	60-3		1971	22	400	601	2.850	299	3	0	0	0
2038	60-8	12	1971	22	400	101	7.400	1056	3	1840	0	0
2039	61-1	11.52	1972	21	400	101	3.000	594	3	2110	0	0
2040	61-2	13.21	1972	21	400	101	23.330	1057	2	1280	0	0
2041	62-1	13.69	1973	20	450	601	15.000	7769	5	2700	0	0
2042	62-2		1973	20	400	101	1.900	0	0	0	0	30
2043	62-3		1973	20	600	701	7.400	2287	4	0	0	28
2044	63-1		1974	19	400	101	3.720	821	4	1520	0	30
2045	63-2	12.3	1974	19	400	653	3.030	1412	5	1520	0	15
2046	63-3		1974	19	450	601	1.200	289	4	0	0	30
2047	63-5		1974	19	500	202	0.500	23	1	0	0	5
2048	64-1		1975	18	400	101	1.560	0	1	0	0	20
2049	65-3		1976	17	400	101	6.190	899	3	0	0	35
2050	65-9		1976	17	400	101	0.610	211	4	1040	0	15
2051	66-2		1977	16	400	101	14.000	1189	3	760	0	35
2052	66-6		1977	16	600	701	2.660	235	2	0	0	0
2053	67-3		1978	15	400	101	6.980	430	2	0	0	30
2054	67-4	10.2	1978	15	400	101	8.080	633	3	900	0	15
2055	67-5	12.89	1978	15	600	601	5.100	1114	4	1180	0	20
2056	67-6		1978	15	400	101	0.670	0	1	0	0	35
2057	67-10		1978	15	100	401	3.100	0	1	0	0	0
2058	68-1	10.92	1979	14	400	101	0.930	231	4	1260	0	23
2059	68-2	10.66	1979	14	600	601	8.920	1853	4	1400	0	0
2060	68-3		1979	14	400	104	3.850	610	3	1020	0	23
2061	68-4	12.98	1979	14	400	104	5.250	774	3	0	0	23
2062	69-1	13.08	1980	13	600	601	8.390	297	1	900	0	38
2063	69-2		1980	13	400	110	3.380	1067	4	0	0	45
2064	69-3		1980	13	450	601	2.160	712	4	1900	0	20
2065	69-4	10.34	1980	13	450	601	1.400	356	4	2340	0	0

2066	69-5		1980	13	450	601	0.960	164	3	0	0	15
2067	69-6		1980	13	450	601	0.110	63	5	0	0	30
2068	78-10		1989	4	450	601	0.980	0	1	0	0	30
2069	78-11		1989	4	450	601	3.250	0	1	0	0	25
2070	70-1		1981	12	450	652	4.730	551	3	1800	0	0
2071	71-1	11.35	1982	11	450	601	5.900	258	1	1200	0	0
2072	71-2	11.86	1982	11	600	601	8.750	387	1	1200	0	0
2073	72-1		1983	10	600	701	1.960	9	1	0	0	25
2074	72-2		1983	10	600	701	1.780	5	1	0	0	25
2075	72-3		1983	10	600	701	2.480	14	1	0	0	25
2076	73-1		1984	9	600	701	2.900	5	1	0	0	35
2077	73-3		1984	9	500	203	0.260	0	1	0	1250	20
2078	74-1		1985	8	500	204	6.000	0	1	0	0	25
2079	74-2		1985	8	500	204	4.740	0	1	0	0	35
2080	74-3		1985	8	500	204	0.280	0	1	0	0	38
2081	74-4		1985	8	500	204	1.370	0	1	0	0	38
2082	75-1		1986	7	500	204	2.580	0	1	0	0	30
2083	76-1		1987	6	600	701	4.450	0	1	0	0	0
2084	76-2		1987	6	600	701	2.650	0	1	0	0	0
2085	76-8		1987	6	450	601	0.450	0	1	0	0	0
2086	76-9		1987	6	400	104	0.630	0	1	0	0	0
2087	77-2		1988	5	400	104	1.040	0	1	0	0	0
2088	77-3		1988	5	400	104	1.340	0	1	0	0	9
2089	77-4		1988	5	400	104	0.740	0	1	0	0	0
2090	77-13		1988	5	400	109	0.280	0	1	0	0	0
2091	78-1		1989	4	450	601	1.580	0	1	0	0	25
2092	78-2		1989	4	450	601	1.830	0	1	0	0	25
2093	78-3		1989	4	400	104	0.560	0	1	0	0	10
2094	78-4		1989	4	400	104	0.100	0	1	0	0	15
2095	78-5		1989	4	500	204	0.250	0	1	0	0	0
2096	78-6		1989	4	400	902	0.380	0	1	0	0	0
2097	78-7		1989	4	600	701	0.190	0	1	0	0	0
2098	78-8		1989	4	400	104	1.770	0	1	0	0	0
2099	78-9		1989	4	400	104	2.300	0	1	0	0	0

2100	79-2		1990	3	500	207	4.690	0	1	0	0	0
2101	79-3		1990	3	600	701	8.600	0	1	0	0	0
2102	79-4		1990	3	500	201	1.100	0	1	0	0	0
2103	79-5		1990	3	500	204	0.150	0	1	0	0	0
2104	81-1		1992	1	400	103	4.000	0	1	0	0	0
2105	81-2		1992	1	400	104	2.320	0	1	0	0	0
2106	81-3A		1992	1	600	701	3.370	0	1	0	0	0
2107	82-1		1992	1	400	103	9.660	0	1	0	0	0
3001	8		1914	79	400	101	0.660	465	5	0	0	10
3002	23		1918	75	400	102	0.250	84	4	0	0	20
3003	26		1918	75	400	101	0.560	334	5	0	0	3
3004	29		1920	73	400	101	0.340	288	5	0	0	10
3005	30	21.84	1920	73	400	101	3.000	2515	5	0	0	5
3006	41		1921	72	400	101	0.200	140	5	0	0	0
3007	42		1921	72	400	103	0.960	479	5	280	0	8
3008	43		1921	72	400	901	0.330	59	3	0	0	5
3009	57-1		1924	69	400	101	0.060	38	5	0	0	20
3010	57-2		1924	69	400	101	0.220	146	5	0	0	10
3011	58		1924	69	400	103	2.740	956	4	280	0	5
3012	72		1928	65	400	101	0.830	551	5	0	0	20
3013	88	18.38	1929	64	400	103	5.630	1630	4	280	0	20
3014	116	17.79	1933	60	400	101	7.500	4065	5	1067	0	15
3015	117		1933	60	400	101	1.800	721	5	0	0	0
3016	126		1935	58	400	103	0.750	350	5	280	0	40
3017	131	18.35	1936	57	400	101	7.250	2064	4	540	0	28
3018	134		1937	56	400	104	0.550	310	5	360	0	5
3019	158	15.07	1941	52	400	101	2.400	1105	5	540	0	8
3020	163	17.94	1943	50	400	101	1.720	420	4	390	0	5
3021	166	19.29	1946	47	400	101	7.500	3742	5	660	0	6
3022	169-1	18.17	1948	45	400	101	6.920	1568	4	620	0	0
3023	169-2		1948	45	400	101	4.960	2143	5	615	0	0
3024	173	17.78	1950	43	400	101	16.170	7122	5	870	0	0
3025	176	16.84	1952	41	400	101	3.750	1377	4	0	0	0
3026	194		1954	39	400	101	0.250	102	5	0	0	0

3027	195		1955	38	400	101	5.710	0	1	0	0	0
3028	195-1		1955	38	400	103	0.700	188	4	0	0	0
3029	195-2	16.53	1955	38	400	101	4.100	1031	4	760	0	0
3030	46-5	15.48	1957	36	600	701	6.510	2752	5	0	0	0
3031	46-6		1957	36	400	101	1.370	384	4	0	0	0
3032	51-15		1962	31	400	101	6.140	0	1	0	0	0
3033	51-18	14.4	1962	31	400	101	8.920	1886	4	800	0	0
3034	51-19		1962	31	400	101	2.220	776	5	0	0	0
3035	51-20		1962	31	400	101	1.140	123	5	0	0	0
3036	51-27		1962	31	400	101	6.600	1772	4	1040	0	0
3037	51-28		1962	31	400	101	3.600	1062	4	700	0	0
3038	51-3	15.14	1962	31	400	101	5.550	833	3	680	0	0
3039	51-4	15.87	1962	31	400	652	11.570	1419	3	580	0	0
3040	51-5		1962	31	400	101	6.140	2828	5	0	0	0
3041	53-1		1964	29	400	101	1.810	535	4	910	0	0
3042	53-2		1964	29	400	101	1.090	244	4	1080	0	0
3043	54-3	13.78	1965	28	600	701	5.670	1144	4	0	0	0
3044	55-2		1966	27	600	601	8.680	2620	4	1600	0	0
3045	56-2	13.22	1967	26	400	101	15.090	1731	3	0	0	0
3046	56-3	13.52	1967	26	400	101	18.030	1335	3	0	0	0
3047	57-1		1968	25	450	601	4.520	592	3	0	0	0
3048	58-3		1969	24	450	601	0.620	168	4	1400	0	0
3049	60-4		1969	24	450	601	2.830	560	3	0	0	0
3050	60-6	12.63	1971	22	600	601	10.350	1173	3	860	0	0
3051	63-4		1974	19	500	202	0.190	20	3	0	0	5
3052	63-6		1974	19	100	401	1.340	0	1	0	0	0
3053	63-7		1974	19	100	402	0.840	0	1	0	0	0
3054	65-4		1976	17	400	101	1.210	430	4	0	0	35
3055	66-7		1977	16	100	401	0.570	0	1	0	0	0
3056	67-11		1978	15	100	401	1.980	0	1	0	0	0
3057	70-2	8.89	1981	12	600	701	1.980	86	1	0	0	38
3058	73-2		1984	9	400	103	3.750	0	1	0	0	30
3059	73-4		1984	9	500	203	0.560	0	1	0	1200	30
3060	73-5		1984	9	400	104	1.940	0	1	0	0	20

3061	74-5		1985	8	400	104	1.340	0	1	0	0	30
3062	75-2		1986	7	600	701	15.760	0	1	0	0	40
3063	76-3		1987	6	400	103	0.110	0	1	0	0	0
3064	76-4		1987	6	400	103	0.520	0	1	0	0	0
3065	76-5		1987	6	400	103	0.370	0	1	0	0	0
3066	76-6		1987	6	400	103	1.700	0	1	0	0	0
3067	76-7		1987	6	400	103	0.650	0	1	0	0	0
3068	76-10		1987	6	400	104	1.390	0	1	0	0	0
3069	76-15		1987	6	400	103	0.900	0	1	0	0	0
3070	77-7		1988	5	500	204	1.280	0	1	0	0	0
3071	77-8		1988	5	500	204	0.690	0	1	0	0	0
3072	77-14		1988	5	550	801	1.710	0	1	0	0	0
3073	77-15		1988	5	500	202	0.730	0	1	0	0	0
3074	77-17		1988	5	400	103	0.370	0	1	0	0	0
3075	77-18		1988	5	400	103	0.610	0	1	0	0	0
3076	78-12		1989	4	400	104	1.100	0	1	0	0	20
3077	79-6		1990	3	450	601	9.250	0	1	0	0	0
3078	79-8		1990	3	400	901	0.160	0	1	0	0	0
3079	79-9		1990	3	550	801	1.230	0	1	0	0	0
3080			1991	2	450	654	0.180	0	1	0	0	0
3081	80-1		1991	2	450	652	0.500	0	1	0	0	45
3082	80-2		1991	2	400	103	0.670	0	1	0	0	0
3083	80-6		1991	2	550	801	0.700	0	1	0	0	0
3084	81-3B		1992	1	600	701	2.860	0	1	0	0	0
3085	82-2		1992	1	450	654	1.660	0	1	0	0	0
6001	6-01		0	1993	600	701	1.600	0	1	0	0	0
6002	6-02		0	1993	9999	300	4.200	0	1	0	0	0
6003	6-03		0	1993	500	208	0.900	0	1	0	0	0
6004	6-04		0	1993	9999	300	0.100	0	1	0	0	0
6005	6-05		0	1993	9999	300	3.480	0	1	0	0	0
6006	1		1910	83	400	101	0.650	490	5	0	0	10
6007	2		1911	82	400	101	0.260	245	5	0	0	13
6008	3		1911	82	400	101	0.120	51	5	0	0	20
6009	5		1914	79	400	101	0.200	89	5	0	0	10

6010	6		1914	79	400	101	0.120	0	1	0	0	15
6011	68		1914	79	400	101	0.120	0	1	0	0	15
6012	35		1920	73	400	101	0.460	149	4	460	0	3
6013	108		1932	61	400	101	0.660	0	1	0	0	15
6014	121		1935	58	400	101	0.200	9	1	0	0	0
6015	154		1940	53	400	101	0.200	61	4	0	0	5
6016	165-1		1943	50	400	101	0.850	531	5	0	0	10
6017	165-2	19.9	1943	50	400	101	1.050	605	5	0	0	0
6018	189		1953	40	400	101	0.830	345	5	0	0	5
6019	190	17.78	1953	40	400	101	2.400	1811	5	0	0	12
6020	45-4		1956	37	400	102	2.420	0	1	0	0	0
6021	46-2	16.62	1957	36	400	101	4.240	2393	5	1080	0	0
6022	171		1958	35	400	101	3.360	1035	4	900	0	0
6023	172		1958	35	400	101	0.710	419	5	0	0	0
6024	50-2		1961	32	450	601	3.440	345	3	0	0	0
6025	50-3		1961	32	400	101	1.660	394	4	0	0	0
6026	51-5	16.27	1962	31	400	101	8.720	2838	4	920	0	0
6027	51-6		1962	31	400	101	7.120	1691	4	0	0	0
6028	51-7	15.96	1962	31	400	101	3.640	1595	5	0	0	0
6029	51-22		1962	31	400	102	3.400	0	0	0	0	0
6030	51-23		1962	31	400	102	3.400	0	0	0	0	0
6031	51-25	15.66	1962	31	400	101	5.950	1813	4	0	0	0
6032	51-26		1962	31	450	601	0.360	65	3	0	0	0
6033	57-2		1968	25	400	104	3.400	409	3	0	0	0
6034	58-5	15.5	1969	24	400	101	1.130	373	4	920	0	0
6035	60-5		1971	22	400	101	3.160	583	3	0	0	0
6036	61-5		1972	21	400	101	1.680	322	3	0	0	0
6037	61-6	11.22	1972	21	400	108	0.260	20	2	0	0	0
6038	67-7		1978	15	600	701	12.000	422	1	0	0	0
6039	67-12		1978	15	100	401	0.160	0	1	0	0	0
6040	67-13		1978	15	100	401	0.420	0	1	0	0	0
6041	69-9	10.28	1980	13	400	102	15.500	1157	2	0	0	0
6042	69-10	10.13	1980	13	450	601	10.060	1259	3	0	0	0
6043	71-4		1982	11	100	401	0.200	0	1	0	0	0

6044	71-5		1982	11	100	401	0.400	0	1	0	0	0
6045	77-12		1988	5	500	202	0.610	0	1	0	0	0
6046	78-14		1989	4	400	104	0.450	0	1	0	0	0
6047	78-15		1989	4	500	204	2.660	0	1	0	0	28
6048	78-16		1989	4	600	701	2.130	0	1	0	0	0
6049	78-17		1989	4	600	701	0.180	0	1	0	0	0
6050	79-11		1990	3	100	401	0.380	0	1	0	0	0
6051	79-12		1990	3	100	401	0.430	0	1	0	0	0
6052	80-4		1991	2	550	801	1.450	0	1	0	0	0
6053	82-3		1992	1		500	0.650	0	1	0	0	0
6054	82-4		1992	1		500	0.980	0	1	0	0	0
6055	80-5		1991	2	400	300	0.880	0	1	0	0	0

Where

Stand Code*-

100: Bamboo
300: Natural forest
400: Conifers
450: Mixed conifers
500: Broad-leaved forest
550: Mixed broad-leaved forest
600: Mixed forest
9999: Unknown

Tree Code*-

101:	201	601
102:	202	652
103	203	653
104	204	654
105	205	701
106	206	801
107	207	901
108	208	902
109	401	903
110	402	300

Appendix G. The VISTA Programme (a) IDRISI batch file for calculating the 'Satisfaction' independent variables for each cell in the Study Area

```
unit vista4;

interface

uses
  Windows, Messages, SysUtils, Classes, Graphics, Controls, Forms, Dialogs,
  StdCtrls;

type
  TForm1 = class(TForm)
    Button1: TButton;
    OpenDialog1: TOpenDialog;
    procedure Button1Click(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  Form1: TForm1;

implementation

{$R *.DFM}

procedure TForm1.Button1Click(Sender: TObject);
var i, j, k: integer;
    icol, irow, ncols, nrows: variant;
    strcol, strrow: string;
    description: string[14];
    temp: integer;
    orangevalue, maxvalue: real;
    outputfile, valuesfile, docfile: textfile;
    rcw: word;
    CommandLine, ProgramName: string;
    hModule: THandle;
    bEndModule: Boolean;

begin
  {Enter the number of columns in your image after 'ncols:='
  and the number of rows after 'nrows:='}
  ncols:=127;
  nrows:=123;
  chdir('c:\idrisi');
  OpenDialog1.Execute;

  {open up file for output}
  assignfile(outputfile,'c:\idrisi\yulin\natforv.bat');
  rewrite(outputfile);

  {now go through and make the calculation for each cell in the study area}
  for i:=1 to ncols do
```

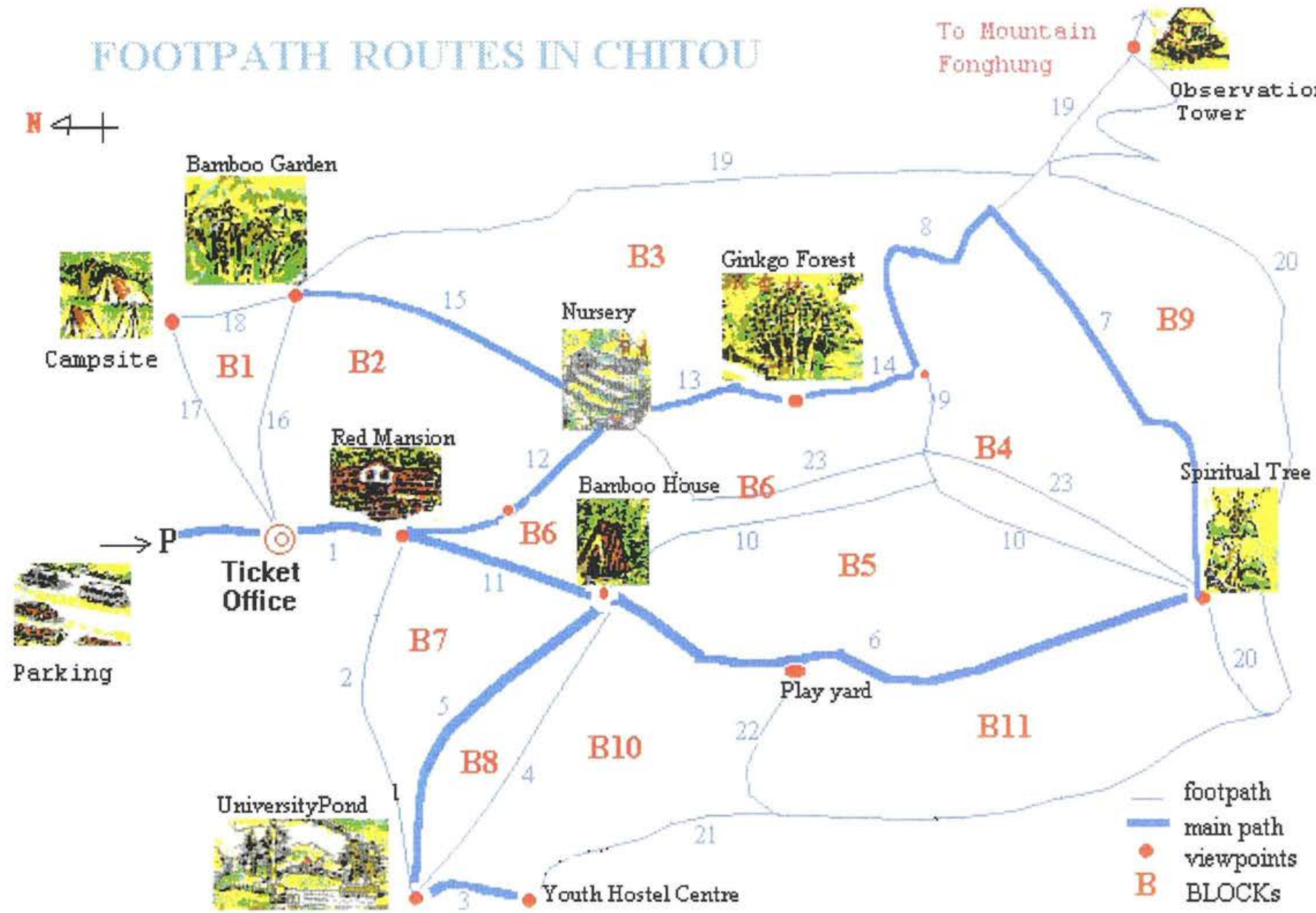
```
begin
  for j:=1 to nrows do
  begin

    {Create a new, blank image filled with zeros}

    CommandLine:='initial x target 1 1 0 1 dtmstudc classes';
    Writeln(outputfile,CommandLine);

    icol:=i-1;
    irow:=j-1;
    strcol:=icol;
    strrow:=irow;
    CommandLine:='update x target 1 '+strrow+' '+strrow+' '+strcol+' '+strcol;
    Writeln(outputfile, commandline);
    CommandLine:='reclass x i target temp1 2 1 0 0 0 1 1 -9999';
    Writeln(outputfile, commandline);
    Commandline:='overlay x 3 temp1 height6c temp2';
    Writeln(outputfile, commandline);
    CommandLine:='overlay x 1 temp2 dtmstudc temp3';
    Writeln(outputfile, commandline);
    CommandLine:='viewshed x temp3 target 2000 1.5 view';
    Writeln(outputfile, CommandLine);
    CommandLine:='overlay x 3 view studarea view2';
    Writeln(outputfile, CommandLine);
    CommandLine:='extract x view2 orange4 1 4 '+strcol+'o'+strrow;
    Writeln(outputfile, CommandLine);
    CommandLine:='extract x view2 brown2 1 4 '+strcol+'b'+strrow;
    Writeln(outputfile, CommandLine);
    CommandLine:='extract x view2 complex5 1 4 '+strcol+'c'+strrow;
    Writeln(outputfile, CommandLine);
    CommandLine:='area x view2 2 1 '+strcol+'a'+strrow;
    Writeln(outputfile, CommandLine);

  end; {j loop}
 end; {i loop}

 closefile(outputfile);

end;

end.
```

Appendix G. The VISTA Programme (b) This programme reads Attribute Value Files that are created from IDRISI batch files to produce each 'Satisfaction' variable's visible image (an Attribute Value File contains the attributes of each feature in a map).

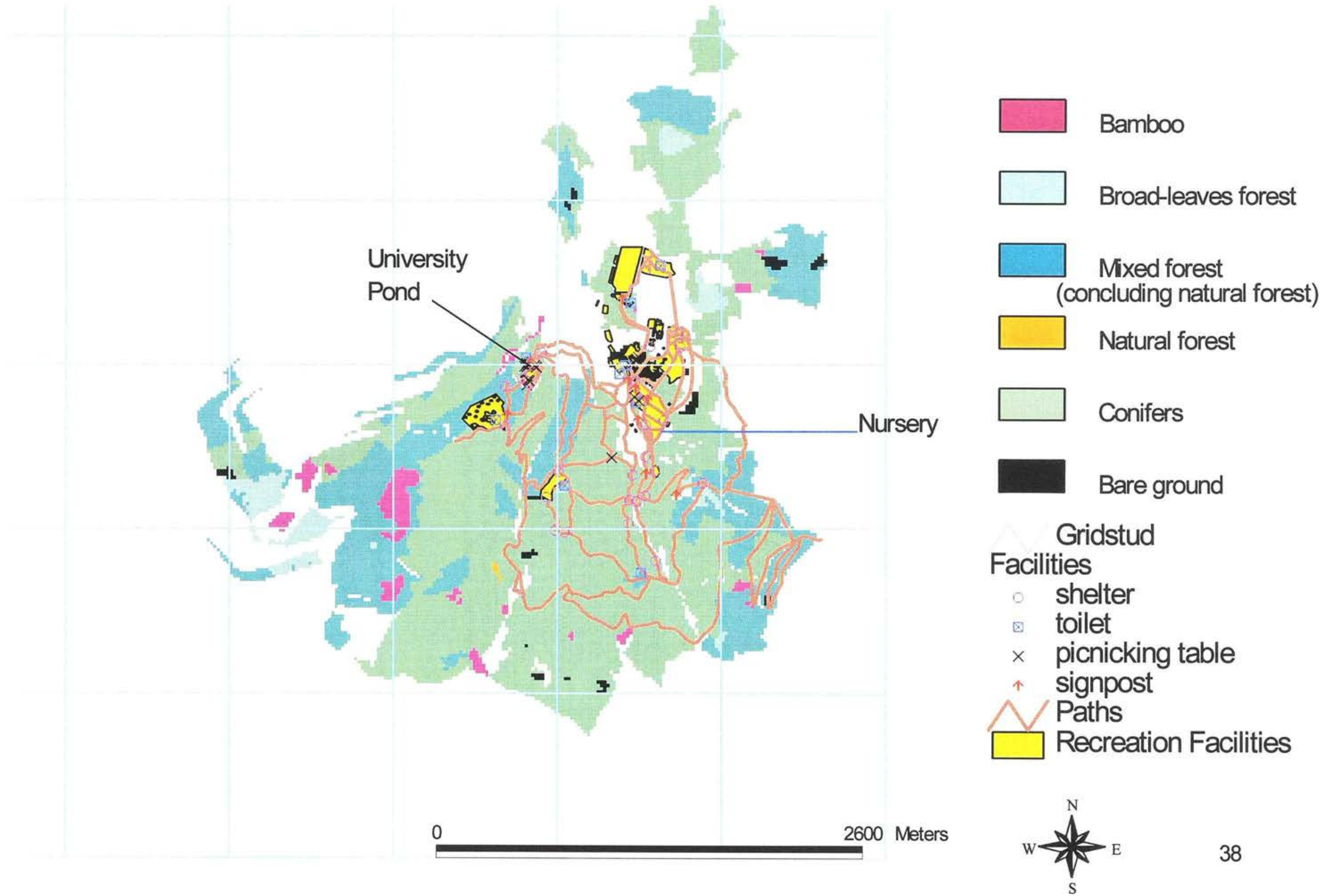
```
unit Vista10;

interface

uses
  Windows, Messages, SysUtils, Classes, Graphics, Controls, Forms, Dialogs,
  StdCtrls;

type
  TForm1 = class(TForm)
    Button1: TButton;
    procedure Button1Click(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  Form1: TForm1;

implementation

{$R *.DFM}

procedure TForm1.Button1Click(Sender: TObject);
var  imagefile, valuesfile: textfile;
     ncols, nrows, i, j, identifier: integer;
     varcol, varrow: variant;
     strcol, strrow: string;
     filename: string;
     orangeindex: real;

begin

    ncols:=3; {127}
    nrows:=123;
    assignfile(imagefile,'c:\idrisi\yulin\visare42.img');
    rewrite(imagefile);
    for i:=0 to nrows-1 do
    begin
      for j:=122 {0} to 124{ncols-1} do
      begin
        varcol:=j; varrow:=i;
        strcol:=varcol; strrow:=varrow;
        filename:='c:\idrisi\yulin2\'+strcol+'a'+strrow+'.val';
        Button1.Caption:=filename;
        assignfile(valuesfile,filename);
        reset(valuesfile);
        readln(valuesfile);
```

```
      readln(valuesfile, identifier, orangeindex);
      writeln(imagefile,orangeindex:8:4);
      closefile(valuesfile);
    end; {j loop}
  end; {i loop}
  closefile(imagefile);

end;

end.
```

Appendix H. The current path system in Chitou (simplified to illustrate their location only) and defined 11 zones for new path location study.



Appendix I. The Forest and Recreation Resource Distribution Map in Chitou for Colour Distribution Studies



Appendix J (A) The analysis result of 15 Landscape Psychological Comparison Pairs to the most favoured photograph in Large Scale.

Table 1-1. Perception of the most favourite landscape photograph- Photograph 1 in large scale

Landscape Perception Pairs	Mean	X^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	-3.742	15.2903	4	.0041**
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-0.774	#11.6774	8	.1662
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-0.71	#9.9355	8	.2696
4. Bright 5 4 3 2 1 2 3 4 5 Dull	-3.613	12.0645	4	.0169*
5. Hard 5 4 3 2 1 2 3 4 5 Soft	-0.29	#6.4516	8	.5968
6. Open 5 4 3 2 1 2 3 4 5 Close	-3.677	18.5161	4	.0010*
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	-2.355	#12.6129	7	.0821
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-4.323	41.0968	4	<.001**
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	-1.742	#14.3871	6	.0256*
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	-3.968	34.3226	4	<.001**
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	-2.267	6.8000	5	.2359
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	-1.968	11.6774	6	.0696
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	-3.968	19.1613	4	.0007**
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-4.097	9.1290	3	.0276**
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	-3.903	25.6129	4	<.001**

(#Warning- Chi-Square statistic is questionable here. 5 cells have expected frequencies less than 5.) **: extremely significant; *: significant

Table 1-2. Perception of the most favourite landscape photograph- Photograph 2 in large scale

Landscape Perception Pairs	Mean	X^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	-4.014	179.7778	7	<.001**
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-.042	12.2500	8	.1404
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	1.111	16.3333	9	.0602
4. Bright 5 4 3 2 1 2 3 4 5 Dull	-2.347	53.7500	8	<.001**
5. Hard 5 4 3 2 1 2 3 4 5 Soft	1.93	14.7465	7	.0394*
6. Open 5 4 3 2 1 2 3 4 5 Close	-4.181	61.1944	4	<.001**
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	-2.361	23.4722	6	.0007**
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-4.208	68.9722	4	<.001**
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	-2.194	23.2778	6	.0007**
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	-3.972	101.8333	6	<.001**
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	-2.873	21.1972	5	.0007**
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	-3.278	105.5556	7	<.001**
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	-3.917	58.6667	5	<.001**
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-4.278	67.4444	4	<.001**
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	-4.097	58.6945	4	<.001**

**: extremely significant; *: significant

Table 1-3. Perception of the most favourite landscape photograph- Photograph 3 in large scale

Landscape Perception Pairs	Mean	X^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	-3.541	41.1351	6	<.001**
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-1.162	#11.2162	7	.1295
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-1	#24.5405	8	.0019**
4. Bright 5 4 3 2 1 2 3 4 5 Dull	-3.73	25.1081	5	<.001**
5. Hard 5 4 3 2 1 2 3 4 5 Soft	1.27	#5.5946	7	.5878
6. Open 5 4 3 2 1 2 3 4 5 Close	-3.946	5.9189	3	.1156
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	-1.5	8.0000	5	.1562
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-1.811	#12.9459	7	.0734
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	-2.568	9.8649	5	.0792
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	-3.865	39.7027	5	<.001**
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	-2.459	21.2162	5	<.001**
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	-2.865	14.0811	5	.0151*
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	-3.865	18.0000	4	.0012**
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-4.081	13.9189	3	.0030**
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	-3.973	6.7838	3	.0791

(#Warning- Chi-Square statistic is questionable here. 5 cells have expected frequencies less than 5.)**: extremely significant; *: significant

Table 1-4. Perception of the most favourite landscape photograph- Photograph 4 in large scale

Landscape Perception Pairs	Mean	X^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	-1.929	24.5714	7	.0009
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-.821	13.4286	8	.0979
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-.426	35.3333	8	<.001**
4. Bright 5 4 3 2 1 2 3 4 5 Dull	-1.179	22.8571	7	.0018
5. Hard 5 4 3 2 1 2 3 4 5 Soft	1.345	10.6000	7	.1570
6. Open 5 4 3 2 1 2 3 4 5 Close	-2.214	16.7500	6	.0102
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	-2.804	31.2500	6	<.001**
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-2.232	23.7143	7	.0013
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	-2.321	30.5714	7	.0001
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	-4.107	45.7857	4	<.001**
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	-3.107	26.2857	5	.0001
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	-0.554	15.4286	9	.0798
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	-3.679	38.2857	5	<.001**
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-3.857	25.9643	4	<.001**
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	-4.071	17.0000	3	.0007

**: extremely significant; *: significant

Table 1-5. Perception of the most favourite landscape photograph- Photograph 5 in large scale

Landscape Perception Pairs	Mean	X^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	-2.154	#3.1538	5	.6763
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-.733	#6.8667	7	.4429
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-.667	#7.9333	7	.3385
4. Bright 5 4 3 2 1 2 3 4 5 Dull	-2.733	#.6667	4	.9554
5. Hard 5 4 3 2 1 2 3 4 5 Soft	1.214	#4.0000	5	.5494
6. Open 5 4 3 2 1 2 3 4 5 Close	-2.214	#9.1429	5	.1035
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	-2.143	#4.8571	5	.4336
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-4.133	#5.0000	3	.1718
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	-2.929	#5.7143	5	.3350
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	-3.867	#16.0000	4	.0030**
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	-3.067	#2.0000	4	.7358
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	-.667	#5.4000	5	.3690
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	-4.067	#3.9333	3	.2688
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-3.6	#10.0000	4	.0404*
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	-3.6	#3.4000	3	.3340

(#Warning- Chi-Square statistic is questionable here. 5 cells have expected frequencies less than 5.), **: extremely significant; *: significant

Table 1-6. Perception of the most favourite landscape photograph- Photograph 6 in large scale

Landscape Perception Pairs	Mean	X^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	-2.800	#1.6000	2	.4493
2. Common 5 4 3 2 1 2 3 4 5 Unusual	1.800	#.0000	4	1.0000
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-2.600	#.0000	4	1.0000
4. Bright 5 4 3 2 1 2 3 4 5 Dull	-2.400	#.6000	3	.8964
5. Hard 5 4 3 2 1 2 3 4 5 Soft	-4.600	#.2000	1	.6547
6. Open 5 4 3 2 1 2 3 4 5 Close	-3.800	#.2000	1	.6547
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	-3.600	#.4000	2	.8187
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-4.800	#1.8000	1	.1797
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	-3.600	#.4000	2	.8187
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	-4.200	#1.8000	1	.1797
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	-1.800	#.6000	3	.8964
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	-.800	#.0000	4	1.0000
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	-3.400	#.4000	2	.8187
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-3.2	#.6000	3	.8964
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	-3.200	#.6000	3	.8964

(#Warning- Chi-Square statistic is questionable here. 3 cells have expected frequencies less than 5.)

Appendix J (B) The analysis result of 15 Landscape Psychological Comparison Pairs to the least favoured photograph in Large Scale.

Table 2-1. Perception of the least favourite landscape photograph- favourite photograph- Photograph 1 in large scale

Landscape Perception Pairs	Mean	X^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	1.286	#2.2857	4	.6834
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-1.429	#.8571	4	.9306
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-.857	#.1429	1	.7055
4. Bright 5 4 3 2 1 2 3 4 5 Dull	.143	#.8571	4	.9306
5. Hard 5 4 3 2 1 2 3 4 5 Soft	-.571	#1.1429	2	.5647
6. Open 5 4 3 2 1 2 3 4 5 Close	-.714	#2.2857	4	.6834
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	1.143	#.8571	4	.9306
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-2	#.7143	5	.9822
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	.143	#.8571	4	.9306
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	-.143	#1.5714	3	.6659
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	1.143	#3.8571	3	.2773
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	.571	#2.2857	4	.6834
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	-.143	#1.5714	3	.6659
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-1.286	#.4286	3	.9343
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	-1	#.8571	4	.9306

(#Warning- Chi-Square statistic is questionable here. **At least** 4 cells have expected
frequencies less than 5.)

Table 2-2. Perception of the least favourite landscape photograph- Photograph 2 in large scale

Landscape Perception Pairs	Mean	X^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	-1.875	#1.0000	5	.9626
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-.625	#.7500	6	.9933
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-.375	#2.0000	4	.7358
4. Bright 5 4 3 2 1 2 3 4 5 Dull	2	#1.0000	5	.9626
5. Hard 5 4 3 2 1 2 3 4 5 Soft	-1.75	#1.0000	5	.9626
6. Open 5 4 3 2 1 2 3 4 5 Close	-1	#1.0000	5	.9626
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	2	#1.0000	5	.9626
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-1.875	#1.0000	5	.9626
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	2.125	#.7500	4	.9450
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	2.25	#3.0000	3	.3916
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	2.5	#3.0000	3	.3916
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	1.125	#1.0000	3	.8013
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	0.75	#1.0000	3	.8013
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-2.5	#3.0000	3	.3916
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	1	#2.5000	5	.7765

(#Warning- Chi-Square statistic is questionable here. **At least** 4 cells have expected
frequencies less than 5.)

Table 2-3. Perception of the least favourite landscape photograph- Photograph 3 in large scale

Landscape Perception Pairs	Mean	X^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	1.314	4.4000	6	.6227
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-2.829	#28.7714	7	.0002**
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-1.618	#5.1176	6	.5288
4. Bright 5 4 3 2 1 2 3 4 5 Dull	-.886	#16.6857	8	.0336*
5. Hard 5 4 3 2 1 2 3 4 5 Soft	-1.657	#13.6000	8	.0928
6. Open 5 4 3 2 1 2 3 4 5 Close	.971	#8.9714	8	.3447
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	2.829	17.2000	6	.0086**
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	3.6	23.8000	5	.0002**
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	2.371	10.4000	6	.1088
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	2.257	11.1143	5	.0492*
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	2.714	9.4000	5	.0941
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	-.657	#41.3714	8	<.001**
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	2.286	24.4000	6	.0004**
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	.343	#15.5143	7	.0299*
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	1.686	9.6000	6	.1425

(#Warning- Chi-Square statistic is questionable here. **At least** 8 cells have expected frequencies less than 5.) **: extremely significant; *: significant

Table 2-4. Perception of the least favourite landscape photograph- Photograph 4 in large scale

Landscape Perception Pairs	Mean	X^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	3.25	#3.0000	3	.3916
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-2.375	#1.0000	5	.9626
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-1.625	#1.0000	3	.8013
4. Bright 5 4 3 2 1 2 3 4 5 Dull	2.125	#.7500	4	.9450
5. Hard 5 4 3 2 1 2 3 4 5 Soft	-2.75	#6.0000	3	.1116
6. Open 5 4 3 2 1 2 3 4 5 Close	2.75	#3.0000	3	.3916
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	1.875	#1.0000	5	.9626
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	3	#4.5000	4	.3425
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	1	#.7500	6	.9933
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	2.25	#2.0000	3	.5724
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	2	#2.0000	3	.5724
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	1.625	#.7500	4	.9450
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	1.125	#1.0000	3	.8013
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	.875	#2.5000	5	.7765
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	.875	#2.0000	4	.7358

(#Warning- Chi-Square statistic is questionable here. **At least** 4 cells have expected frequencies less than 5.)

Table 2-5. Perception of the least favourite landscape photograph- Photograph 5 in large scale

Landscape Perception Pairs	Mean	X^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	2.042	#10.4167	6	.1082
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-1.261	#4.0870	6	.6649
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-.417	#5.7500	6	.4518
4. Bright 5 4 3 2 1 2 3 4 5 Dull	.583	#4.0000	6	.6767
5. Hard 5 4 3 2 1 2 3 4 5 Soft	-.333	#11.0000	6	.0884
6. Open 5 4 3 2 1 2 3 4 5 Close	1.833	#14.0000	5	.0156*
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	1.208	#6.0000	7	.5397
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-.5	#13.3333	6	.0380*
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	.792	#8.6667	6	.1932
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	1.667	#13.3333	6	.0380*
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	1.5	#9.2500	6	.1600
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	1.042	#8.5000	5	.1307
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	1.5	#12.1667	6	.0584
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	.417	#7.3333	7	.3950
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	1	#7.3333	7	.3950

(#Warning- Chi-Square statistic is questionable here. **At least** 6 cells have expected frequencies less than 5.) **: extremely significant; *: significant

Table 2-6. Perception of the least favourite landscape photograph- Photograph 6 in large scale

Landscape Perception Pairs	Mean	X^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	.098	4.9091	8	.7672
2. Common 5 4 3 2 1 2 3 4 5 Unusual	.053	15.4091	8	.0517
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-2.293	79.2782	8	<.001**
4. Bright 5 4 3 2 1 2 3 4 5 Dull	.712	17.0455	8	.0296*
5. Hard 5 4 3 2 1 2 3 4 5 Soft	-3.128	124.0226	7	<.001**
6. Open 5 4 3 2 1 2 3 4 5 Close	-.015	10.8702	8	.2092
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	2.136	49.7727	8	<.001**
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	.598	20.7273	8	.0079**
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	1.192	29.2308	8	.0003**
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	3.344	84.3969	6	<.001**
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	2.955	78.4286	7	<.001**
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	-.759	28.7970	8	.0003**
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	2.909	105.6818	8	<.001**
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	.346	63.4436	8	<.001**
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	2.707	91.8647	8	<.001**

**: extremely significant; *: significant

Appendix J (C) The analysis result of 15 Landscape Psychological Comparison Pairs to the most favoured photograph in Small Scale.

Table 3-1. Perception of the most favourite landscape photograph- Photograph 1 in small scale

Landscape Perception Pairs	Mean	χ^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	-.905	#5.2857	7	.6251
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-1.667	#4.6667	6	.5872
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-.700	#7.2000	7	.4084
4. Bright 5 4 3 2 1 2 3 4 5 Dull	-3.381	#7.8095	4	.0988
5. Hard 5 4 3 2 1 2 3 4 5 Soft	.632	#3.3158	7	.8543
6. Open 5 4 3 2 1 2 3 4 5 Close	-1.619	#9.0000	5	.1091
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	-3.571	6.2381	3	.1006
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-1.667	#6.8571	8	.5521
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	-3.524	#10.1905	4	.0373*
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	-3.952	4.3333	3	.2276
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	-3.286	#4.9524	4	.2922
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	-.714	#5.3333	6	.5018
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	-4.048	2.0000	2	.3679
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-3.190	#11.8571	5	.0368*
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	-3.524	3.1905	3	.3632

(#Warning- Chi-Square statistic is questionable here. **At least** 5 cells have expected frequencies less than 5.) **: extremely significant; *: significant

Table 3-4. Perception of the most favourite landscape photograph- Photograph 4 in small scale

Landscape Perception Pairs	Mean	χ^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	-2.413	19.1733	6	.0039**
2. Common 5 4 3 2 1 2 3 4 5 Unusual	.453	9.3600	8	.3128
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	.162	27.4324	8	.0006**
4. Bright 5 4 3 2 1 2 3 4 5 Dull	-1.892	26.4595	8	.0009**
5. Hard 5 4 3 2 1 2 3 4 5 Soft	1.227	9.8400	8	.2764
6. Open 5 4 3 2 1 2 3 4 5 Close	-1.973	21.9600	7	.0026**
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	-1.324	8.5946	7	.2831
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-2.987	77.2800	8	<.001**
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	-1.784	24.3784	7	.0010**
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	-4.160	102.3600	5	<.001**
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	-2.813	45.6400	7	<.001**
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	-.373	12.2400	8	.1408
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	-3.8	63.8000	5	<.001**
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-4.173	78.6667	4	<.001**
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	-4.027	82.6800	5	<.001**

**: extremely significant; *: significant

Table 3-2. Perception of the most favourite landscape photograph- Photograph 2 in small scale

Landscape Perception Pairs	Mean	χ^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	-.738	14.0984	8	.0792
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-1.230	17.6393	8	.0241*
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-.705	13.5082	8	.0955
4. Bright 5 4 3 2 1 2 3 4 5 Dull	-3.050	41.0667	7	<.001**
5. Hard 5 4 3 2 1 2 3 4 5 Soft	.098	9.6721	8	.2888
6. Open 5 4 3 2 1 2 3 4 5 Close	-1.541	18.8197	8	.0159*
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	-2.729	36.5932	7	<.001**
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-4.148	77.7705	4	<.001**
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	-1.295	14.4098	7	.0444*
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	-4.230	57.2787	4	<.001**
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	-3.934	46.9508	4	<.001**
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	-.754	12.6230	8	.1255
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	-4.066	40.2295	4	<.001**
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-4.066	84.8688	5	<.001**
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	-4.115	136.2623	6	<.001**

**: extremely significant; *: significant

Table 3-5. Perception of the most favourite landscape photograph- Photograph 5 in small scale

Landscape Perception Pairs	Mean	χ^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	-1.500	#8.0000	5	.1562
2. Common 5 4 3 2 1 2 3 4 5 Unusual	1.700	#2.0000	5	.8491
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-.600	#2.0000	4	.7358
4. Bright 5 4 3 2 1 2 3 4 5 Dull	-.100	#2.0000	4	.7358
5. Hard 5 4 3 2 1 2 3 4 5 Soft	.899	#2.3333	5	.8014
6. Open 5 4 3 2 1 2 3 4 5 Close	-.5	#.8000	5	.9770
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	-3.333	#1.5556	4	.8168
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-3.300	#1.4000	2	.4966
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	-1.889	#1.5556	4	.8168
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	-2.800	#1.0000	4	.9098
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	-2.600	#10.8000	3	.0129*
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	-1.000	#4.4000	5	.4934
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	-2.700	#2.0000	5	.8491
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-4.000	#4.4000	3	.2214
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	-3.900	#2.6000	2	.2725

(#Warning- Chi-Square statistic is questionable here. **At least** 4 cells have expected frequencies less than 5.) **: extremely significant; *: significant

Table 3-3. Perception of the most favourite landscape photograph- Photograph 3 in small scale

Landscape Perception Pairs	Mean	χ^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	-2.722	#6.0000	5	.3062
2. Common 5 4 3 2 1 2 3 4 5 Unusual	.222	#12.6667	5	.0267*
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-.889	#8.6667	7	.2775
4. Bright 5 4 3 2 1 2 3 4 5 Dull	-2.889	#3.1111	4	.5394
5. Hard 5 4 3 2 1 2 3 4 5 Soft	-1.167	#2.2222	6	.8982
6. Open 5 4 3 2 1 2 3 4 5 Close	-2.389	#4.6667	5	.4579
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	-1.722	#6.8889	6	.3312
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-3.278	#8.0000	5	.1562
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	-1.167	#5.3333	6	.5018
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	-3.722	#7.5556	4	.1093
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	-2.556	#4.7778	4	.3109
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	.278	#5.1111	7	.6464
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	-3.5	#5.5556	3	.1354
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-4.222	2.3333	2	.3114
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	-4.222	2.3333	2	.3114

(#Warning- Chi-Square statistic is questionable here. **At least** 4 cells have expected frequencies less than 5.) **: extremely significant; *: significant

Table 3-6. Perception of the most favourite landscape photograph- Photograph 6 in small scale

Landscape Perception Pairs	Mean	χ^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	-2.419	#27.9355	6	<.001**
2. Common 5 4 3 2 1 2 3 4 5 Unusual	2.065	#7.6129	6	.2679
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	.806	#14.1613	7	.0484*
4. Bright 5 4 3 2 1 2 3 4 5 Dull	-1.065	#14.5806	8	.0678
5. Hard 5 4 3 2 1 2 3 4 5 Soft	1.613	#19.3226	7	.0072**
6. Open 5 4 3 2 1 2 3 4 5 Close	-2.645	11.0000	5	.0514
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	-2.548	#8.5161	6	.2027
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-3.935	16.5806	4	.0023**
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	-3.903	21.4194	4	<.001**
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	-4.387	23.5806	3	<.001**
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	-3.419	5.9355	4	.2040
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	-.742	#9.0000	7	.2527
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	-4.065	12.7419	3	.0052**
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-4.290	20.4839	3	<.001**
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	-4.258	18.9355	3	<.001**

(#Warning- Chi-Square statistic is questionable here. **At least** 6 cells have expected frequencies less than 5.) **: extremely significant; *: significant

Appendix J (D) The analysis result of 15 Landscape Psychological Comparison Pairs to the least favoured photograph in Small Scale.

Table 4-1. Perception of the least favourite landscape photograph- Photograph 1 in small scale

Landscape Perception Pairs	Mean	χ^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	2.631	25.7077	7	.0006**
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-2.877	54.2154	8	<.001**
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-.585	22.9231	8	.0035**
4. Bright 5 4 3 2 1 2 3 4 5 Dull	-.185	44.5231	8	<.001**
5. Hard 5 4 3 2 1 2 3 4 5 Soft	-1.270	14.5873	7	.0417*
6. Open 5 4 3 2 1 2 3 4 5 Close	1.938	12.6462	6	.0490*
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	1.877	25.9692	8	.0011**
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	3.200	79.1385	8	<.001**
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	-.138	8.8000	8	.3594
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	1.692	20.7846	7	.0041**
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	2.323	19.0615	7	.0080**
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	-.923	41.4615	7	<.001**
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	1.400	30.1385	7	.0001**
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	2.523	38.9846	8	<.001**
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	2.077	11.5692	6	.0723

**: extremely significant; *: significant

Table 4-4. Perception of the least favourite landscape photograph- Photograph 4 in small scale

Landscape Perception Pairs	Mean	χ^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	2.375	#2.0000	4	.7358
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-.875	#2.0000	4	.7358
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-.500	#3.0000	3	.3916
4. Bright 5 4 3 2 1 2 3 4 5 Dull	.250	#2.0000	4	.7358
5. Hard 5 4 3 2 1 2 3 4 5 Soft	0	#.0000	3	1.0000
6. Open 5 4 3 2 1 2 3 4 5 Close	2.625	#2.0000	4	.7358
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	2.250	#1.0000	3	.8013
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	2.125	#4.5000	4	.3425
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	-.250	#2.0000	4	.7358
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	.500	#3.0000	3	.3916
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	1.375	#3.0000	3	.3916
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	-1.125	#3.0000	3	.3916
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	.875	#3.2500	2	.1969
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-.375	#3.2500	2	.1969
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	.875	#2.0000	4	.7358

(#Warning- Chi-Square statistic is questionable here. **At least** 3 cells have expected frequencies less than 5.) **: extremely significant; *: significant

Table 4-2. Perception of the least favourite landscape photograph- Photograph 2 in small scale

Landscape Perception Pairs	Mean	χ^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	2.045	#7.2727	6	.2964
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-1.182	#3.4545	6	.7500
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	0	#8.2727	8	.4073
4. Bright 5 4 3 2 1 2 3 4 5 Dull	.682	#9.0909	8	.3347
5. Hard 5 4 3 2 1 2 3 4 5 Soft	-.364	#11.0909	6	.0856
6. Open 5 4 3 2 1 2 3 4 5 Close	.909	#9.8182	6	.1325
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	2.318	#9.1818	6	.1636
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-.864	#6.6364	6	.3558
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	1.5	#7.9091	6	.2448
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	1.5	#6.6364	6	.3558
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	1.727	#9.1818	6	.1636
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	1.048	#11.6190	4	.0204*
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	.955	#6.6364	6	.3558
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	.636	#7.4545	5	.1890
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	.955	#16.1818	6	.0128*

(#Warning- Chi-Square statistic is questionable here. **At least** 5 cells have expected frequencies less than 5.) **: extremely significant; *: significant

Table 4-5. Perception of the least favourite landscape photograph- Photograph 5 in small scale

Landscape Perception Pairs	Mean	χ^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	2.452	30.7849	7	.0001**
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-1.656	25.1613	8	.0015**
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-.022	65.5604	8	<.001**
4. Bright 5 4 3 2 1 2 3 4 5 Dull	1.250	20.5000	8	.0086**
5. Hard 5 4 3 2 1 2 3 4 5 Soft	.141	63.9348	8	<.001**
6. Open 5 4 3 2 1 2 3 4 5 Close	1.837	42.6087	8	<.001**
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	1.348	15.4130	8	.0516
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-2.076	45.7391	8	<.001**
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	.620	39.8696	8	<.001**
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	1.380	41.0435	8	<.001**
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	1.849	46.8387	8	<.001**
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	1.772	38.5000	8	<.001**
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	1.527	29.0645	7	.0001**
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-.237	18.0753	9	.0343*
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	1.237	22.2581	8	.0045**

**: extremely significant; *: significant

Table 4-3. Perception of the least favourite landscape photograph- Photograph 3 in small scale

Landscape Perception Pairs	Mean	χ^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	2.000	#2.2857	4	.6834
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-2.714	#.8571	4	.9306
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-1.000	#.2857	2	.8669
4. Bright 5 4 3 2 1 2 3 4 5 Dull	2.429	#3.8571	3	.2773
5. Hard 5 4 3 2 1 2 3 4 5 Soft	-2.286	#1.5714	3	.6659
6. Open 5 4 3 2 1 2 3 4 5 Close	1.714	#1.5714	3	.6659
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	1.000	#.6667	3	.8810
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-3.429	#.4286	3	.9343
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	.857	#.4286	3	.9343
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	.143	#1.5714	3	.6659
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	.143	#1.5714	3	.6659
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	.714	#.8571	4	.9306
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	.714	#.4286	3	.9343
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-2.429	#.4286	3	.9343
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	.429	#2.2857	4	.6834

(#Warning- Chi-Square statistic is questionable here. **At least** 4 cells have expected frequencies less than 5.)

Table 4-6. Perception of the least favourite landscape photograph- Photograph 6 in small scale

Landscape Perception Pairs	Mean	χ^2	DF	P
1. Large Scale 5 4 3 2 1 2 3 4 5 Small Scale	1.000	#5.2857	7	.6251
2. Common 5 4 3 2 1 2 3 4 5 Unusual	-.810	#2.0000	6	.9197
3. Angular 5 4 3 2 1 2 3 4 5 Rounded	-.190	#8.0000	6	.2381
4. Bright 5 4 3 2 1 2 3 4 5 Dull	.714	#4.5238	7	.7178
5. Hard 5 4 3 2 1 2 3 4 5 Soft	-.810	#12.000	8	.1512
6. Open 5 4 3 2 1 2 3 4 5 Close	1.238	#6.8095	7	.4490
7. Varied 5 4 3 2 1 2 3 4 5 Monotonous	2.571	#6.0000	6	.4232
8. Natural 5 4 3 2 1 2 3 4 5 Man-made	-.905	#7.3333	6	.2911
9. Colourful 5 4 3 2 1 2 3 4 5 Colourless	.810	#4.2857	8	.8305
10. High 5 4 3 2 1 2 3 4 5 Low Scenic Value	1.952	#6.8095	7	.4490
11. Interesting 5 4 3 2 1 2 3 4 5 Boring	2.238	#.4286	5	.9945
12. Obvious 5 4 3 2 1 2 3 4 5 Mysterious	.429	#4.5238	7	.7178
13. Beautiful 5 4 3 2 1 2 3 4 5 Ugly	1.714	#5.3333	6	.5018
14. Peaceful 5 4 3 2 1 2 3 4 5 Crowded	-.476	#12.9048	7	.0745
15. Pleasant 5 4 3 2 1 2 3 4 5 Unpleasant	1.476	#3.2857	5	.6560

(#Warning- Chi-Square statistic is questionable here. **At least** 6 cells have expected frequencies less than 5.) **: extremely significant; *: significant

Appendix K. The IDRISI macro command for the calculation approach of the Satisfaction Model to produce the Satisfaction Map.

"scalar x *brownness*[1] *brownness2* 3 1.1283" (STEP 1)
"scalar x *natural forest natural forest2* 3 0.6062"
"scalar x *landscape diversity landscape diversity2* 3 0.7708"
"scalar x *orangeness orangeness2* 3 1.5427"
"scalar x *pure forest pure forest2* 3 0.9182"

****

Running this module in batch mode requires five parameters:	Operation options are:
1 : x (to indicate that batch mode is being used)	1 : Add
2 : input image name (the file to be acted upon)	2 : Subtract
3 : output image (the new image to be created)	3 : Multiply
4 : operation number (the operation to be performed)	4 : Divide
5 : the scalar value (the value to be used in that operation)	5 : Exponentiate

****

"overlay x 3 *brownness2 natural forest2 Temp1*"
"overlay x 2 *Temp1 landscape diversity2 Temp2*"
"overlay x 2 *Temp2 orangeness2 Temp1*"
"overlay x 2 *Temp1 pure forest2 Temp2*"

****

Running this module in batch mode requires five parameters:	Operation options are:
1 : x (to indicate that batch mode is being used)	1 : Add
2 : operation number (overlay operation -- see options below)	2 : Subtract
	3 : Multiply
3 : first input image (the first image in the overlay)	4 : Ratio (first/second)
4 : second input image (the second image in the overlay)	5 : Normalized Ratio ((first-second)/(first+second))
5 : output file name (the new image file to be created)	6 : Exponentiate (first to the power of the second)

****

"scalar x *Temp2 Temp1* 1 0.1965"

"scalar x *Temp1 Temp2* 3 -1" (STEP 2)

"transfor x Temp2 Temp1 3" (STEP 3)

****

Running this module in batch mode requires four parameters:	Transformation options are:
1 : x (to indicate that batch mode is being used)	1 = (1/x)
2 : input file name (the image that will be transformed)	2 = ln(x)
3 : output file name (the new file that results from the transformation)	3 = exp(x)
4 : transformation type (the number code of the transformation desired)	

****

"scalar x *Temp1 Temp2* 1 1" (STEP 4)

"transfor x Temp2 Temp1 1" (STEP 5)

[1] All filenames are limited to 8 characters during IDRISI operations. For illustration, they are lengthened with long filenames.